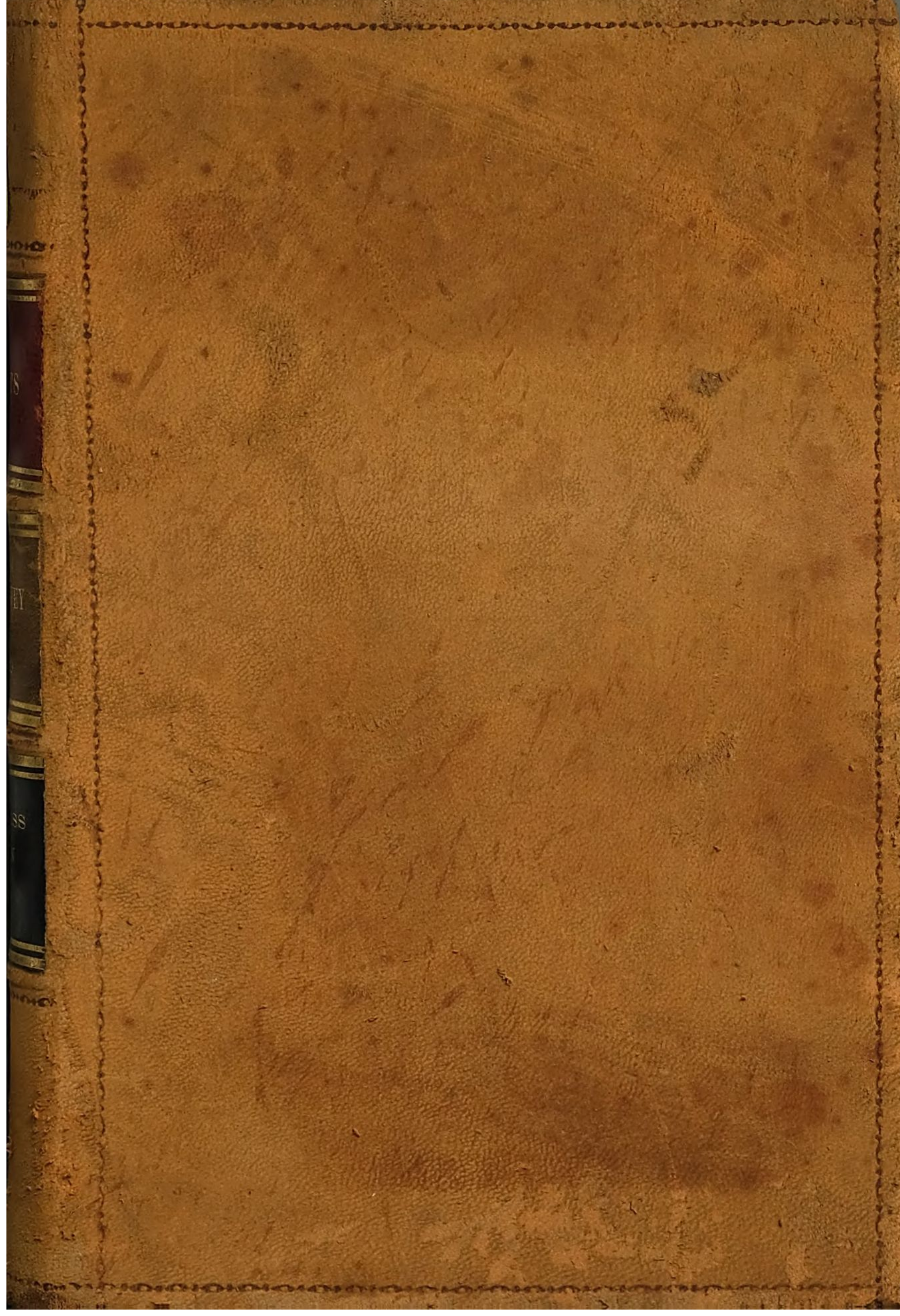


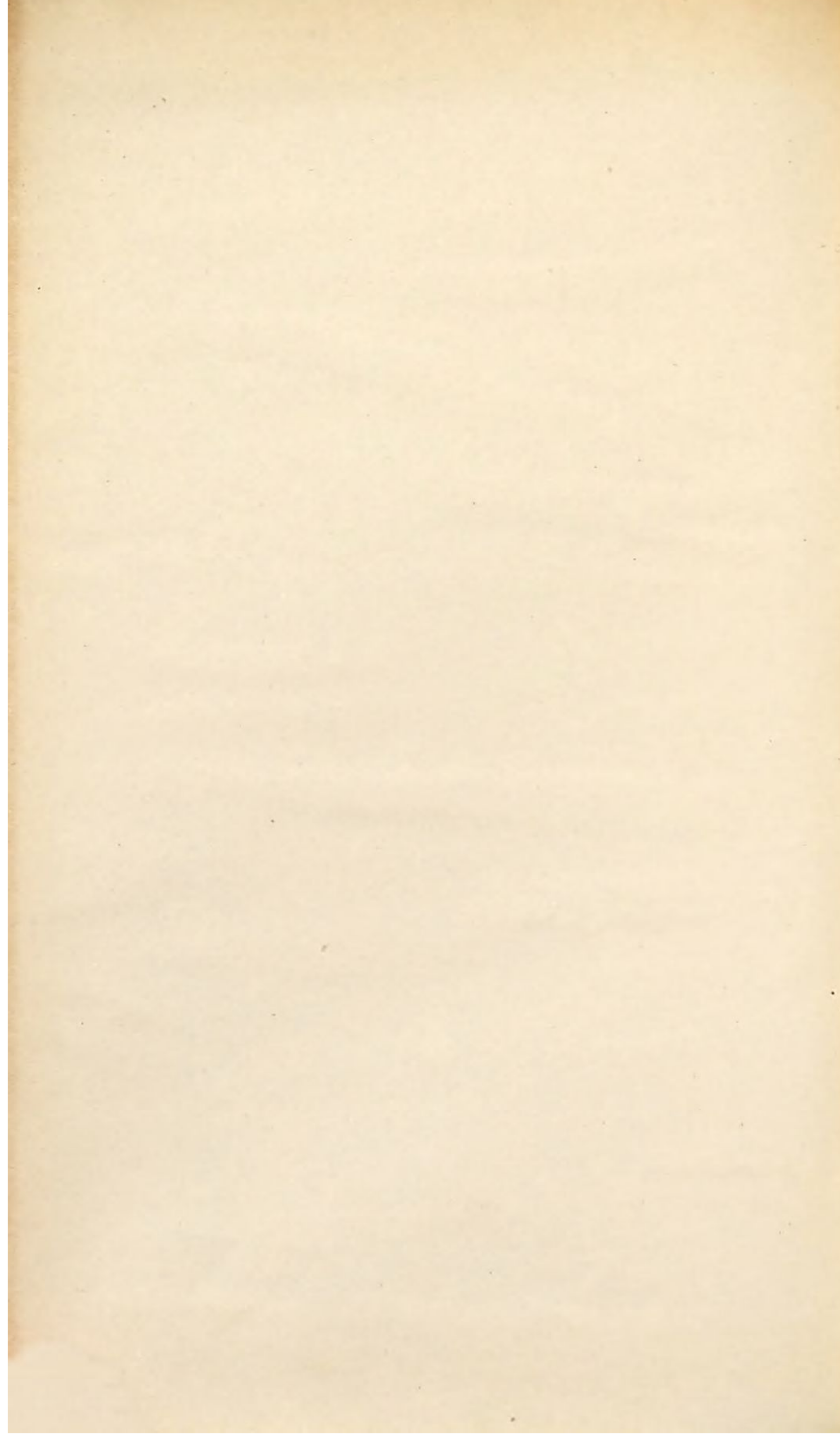


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No. 123

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113. A report of work done in the Division of Chemistry during the fiscal years 1891-'92 and 1892-'93. F. W. Clarke, chief chemist. 1893. 8°. 115 pp. Price 15 cents.
114. Earthquakes in California in 1893, by Charles D. Perrine. 1894. 8°. 23 pp. Price 5 cents.
115. A Geographic Dictionary of Rhode Island, by Henry Gannett. 1894. 8°. 31 pp. Price 5 cents.
116. A Geographic Dictionary of Massachusetts, by Henry Gannett. 1894. 8°. 126 pp. Price 15 cents.
117. A Geographic Dictionary of Connecticut, by Henry Gannett. 1894. 8°. 67 pp. Price 10 cents.
118. A Geographic Dictionary of New Jersey, by Henry Gannett. 1894. 8°. 131 pp. Price 15 cents.
119. A Geologic Reconnaissance in Northwest Wyoming, by George Homans Eldridge. 1894. 8°. 72 pp. Price 10 cents.
120. The Devonian System of Eastern Pennsylvania and New York, by Charles S. Prosser. 1894. 8°. 81 pp. Price 10 cents.
121. A Bibliography of North American Paleontology, by Charles Rollin Keyes. 1894. 8°. 251 pp. Price 20 cents.
122. Results of Primary Triangulation, by Henry Gannett. 1894. 8°. 412 pp. 17 pl. Price 25 cents.
123. A Dictionary of Geographic Positions, by Henry Gannett. 1895. 8°. 183 pp. Price 15 cents.
124. Revision of North American Fossil Cockroaches, by Samuel Hubbard Scudder. 1895. 8°. 176 pp. Price 15 cents.
125. The Constitution of the Silicates, by Frank Wigglesworth Clarke. 1895. 8°. 109 pp. Price 15 cents.
128. The Bear River Formation and its Characteristic Fauna, by Charles A. White. 1895. 8°. 108 pp. Price 15 cents.
129. Earthquakes in California in 1894, by Charles D. Perrine. 1895. 8°. 25 pp. Price 5 cents.

In press:

126. A Mineralogical Lexicon, by Benjamin Kendall Emerson.
127. Catalogue of Contributions to North American Geology, 1732-1894, by Nelson Horatio Darton.
130. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for 1892 and 1893, by Fred Boughton Weeks.
131. Water-supply Data Obtained During the Calendar Years 1893 and 1894 by the Division of Hydrography, by F. H. Newell, topographer in charge.

In preparation:

- The Moraines of the Missouri Coteau and their attendant deposits, by James Edward Todd.
- Volcanic Rocks of South Mountain, Pennsylvania, by Florence Bascom.
- Geology of the Fort Riley Military Reservation, by Robert Hay.
- The Fauna of the Knoxville Beds, by T. W. Stanton.
- The Disseminated Lead Ores of Southeastern Missouri, by Arthur Winslow.
- The Cambrian Rocks of Pennsylvania, by Charles Doolittle Walcott.

STATISTICAL PAPERS.

- Mineral Resources of the United States, 1882, by Albert Williams, jr. 1883. 8°. xvii, 813 pp. Price 50 cents.
- Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.
- Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.
- Mineral Resources of the United States, 1886, by David T. Day. 1887. 8°. viii, 813 pp. Price 50 cents.
- Mineral Resources of the United States, 1887, by David T. Day. 1888. 8°. vii, 832 pp. Price 50 cents.
- Mineral Resources of the United States, 1888, by David T. Day. 1890. 8°. vii, 652 pp. Price 50 cents.
- Mineral Resources of the United States, 1889 and 1890, by David T. Day. 1892. 8°. viii, 671 pp. Price 50 cents.
- Mineral Resources of the United States, 1891, by David T. Day. 1893. 8°. vii, 630 pp. Price 50 cents.
- Mineral Resources of the United States, 1892, by David T. Day. 1893. 8°. vii, 850 pp. Price 50 cents.
- Mineral Resources of the United States, 1893, by David T. Day. 1894. 8°. viii, 810 pp. Price 50 cents.

The money received from the sale of these publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by POSTAL NOTE or MONEY ORDER, made payable to the Chief Clerk of the U. S. Geological Survey, or in CURRENCY for the exact amount. Correspondence relating to the publications of the Survey should be addressed

TO THE DIRECTOR OF THE

UNITED STATES GEOLOGICAL SURVEY,

WASHINGTON, D. C.

WASHINGTON, D. C., *July, 1895.*

DEPARTMENT OF THE INTERIOR

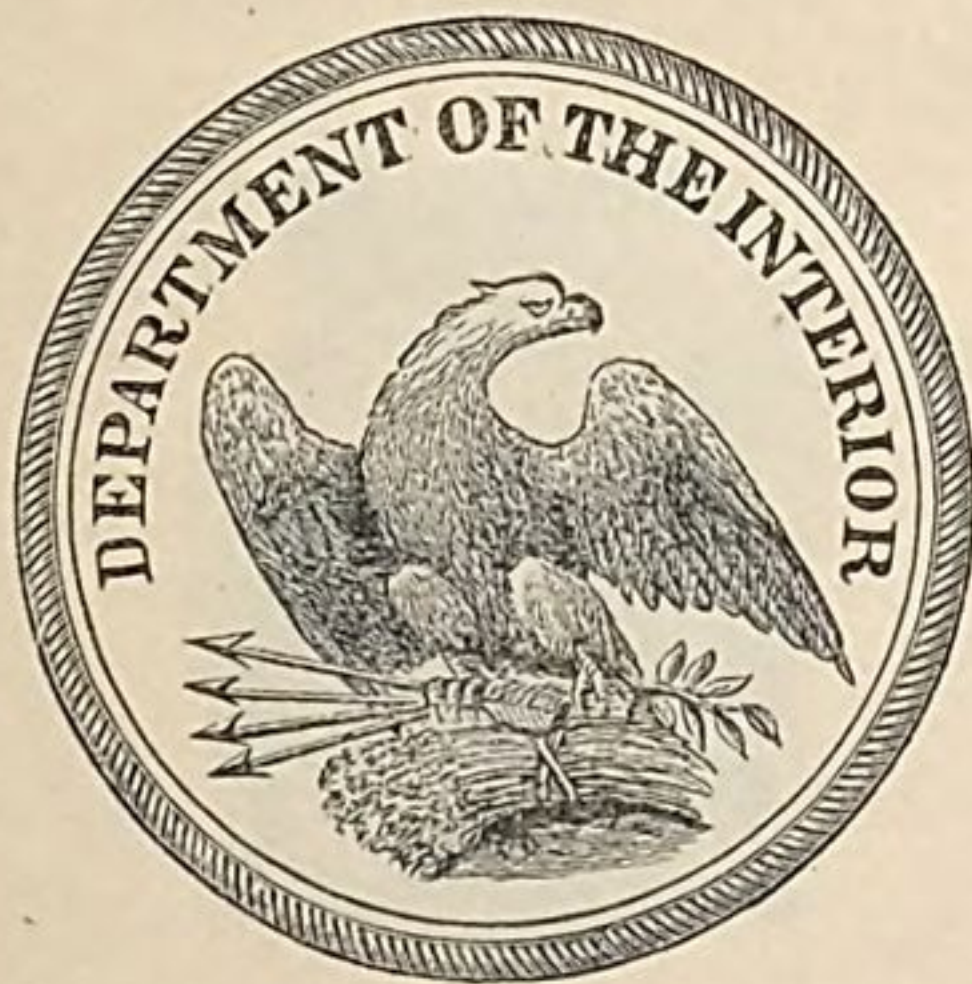
BULLETIN

OF THE

UNITED STATES

GEOLOGICAL SURVEY

No. 123



WASHINGTON

GOVERNMENT PRINTING OFFICE

1895

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

A

DICTIONARY OF GEOGRAPHIC POSITIONS

IN

THE UNITED STATES

COMPILED BY

HENRY GANNETT

CHIEF TOPOGRAPHER



WASHINGTON

GOVERNMENT PRINTING OFFICE

1895



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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF TOPOGRAPHY,
Washington, D. C., November 23, 1894.

SIR: I beg to transmit herewith, for publication as a bulletin, a compilation of positions determined within the limits of the United States.

Very respectfully,

HENRY GANNETT,
Chief Topographer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

A DICTIONARY OF GEOGRAPHIC POSITIONS.

BY HENRY GANNETT.

INTRODUCTION.

For several years the Division of Topography of the United States Geological Survey has been engaged in compiling positions determined within the United States which are believed to be of sufficient accuracy for use in the preparation of its maps. This compilation has been found extremely useful in the office, and it is believed that its usefulness will be greatly extended by placing it before the public.

This list comprises between 9,000 and 10,000 positions. To publish it in extenso, with descriptions of the stations, their latitudes and longitudes, the distances and azimuths to neighboring stations, and the methods of determination, would extend this bulletin beyond all reasonable limits. To avoid making too bulky a volume, it has been decided to publish merely the latitudes and longitudes, with abbreviations indicating the authority, and references to the publications in which other data relating to the positions may be found.

The arrangement of these positions is the result of much thought, and that presented is believed to be the most convenient for the purposes for which such a compilation is needed. The positions are arranged by States and, within States, by "square degrees;" i. e., the quadrilateral limited by consecutive parallels and meridians. The States are arranged geographically, beginning with Maine and ending with California. Within the States the square degrees commence with the northeasternmost and run westward across the State; then they begin again with the eastern end of the next tier southward, and so on to the southwest corner of the State.

Within each square degree the positions are arranged alphabetically by name. The only exception to this is in the case of section corners in certain States on the prairies and plains. These section corners will be found at the end of their respective square degrees.

The controlling reason for the selection of this method of arrangement is that the most common requirement is for all positions within a certain area, and since that area may be large, such as the area of the State, or small, as, for instance, the neighborhood of a city, such

a requirement will be met by this arrangement better than by any other, except, possibly, an arrangement by counties. An unbroken alphabetical arrangement, either by States or by the United States, would be practically worthless for the use of surveyors.

AUTHORITIES.

The authorities which have contributed in any appreciable degree to geodetic determinations of positions in this country are few in number. They are as follows:

United States Coast and Geodetic Survey.

United States Geological Survey.

United States Lake Survey.

Mississippi River Commission.

Missouri River Commission.

United States Geological and Geographical Survey of the Territories. (Hayden Survey.)

United States Geographical and Geological Survey of the Rocky Mountain Region. (Powell Survey.)

United States Geographical Surveys West of the One Hundredth Meridian. (Wheeler Survey.)

New York State Survey.

By the above nine organizations 99 per cent of all determinations have been made. In addition to these a few determinations have been made by the United States Engineer Corps, by the New Jersey State Survey, by observatories, etc.

It is in order here to describe the work of each of these nine organizations, the parts of the country in which their work has been done, its extent, and the methods employed both in field and office, and to characterize the degree of accuracy which may be expected in their determinations.

UNITED STATES COAST AND GEODETIC SURVEY.

This organization, the oldest in the country, has been engaged in geodetic work for more than half a century. Its determinations are found all along the coast of the Atlantic, Gulf, and Pacific. Besides the work immediately connected with the coast, it has extended its triangulation and astronomic determinations of positions far inland in many directions and for different purposes. The greater part of New England, New York, and New Jersey, and much of Pennsylvania, are covered by its positions. From the head of Chesapeake Bay it has extended a series of quadrilaterals southwestward down the east front of the Appalachian Mountains to central Alabama. It has extended a belt of triangulation across the United States in the neighborhood of the thirty-ninth parallel. In aid of State surveys it has done much triangulation in interior States, including Wisconsin, Minnesota, Kentucky, and Tennessee.

Altogether many thousands of points of primary, secondary, and tertiary grades have been determined. Most of those published in the reports of this organization, however, rest upon fundamental data which are now discarded. Those published in the reports prior to 1870 rested upon chronometric determinations from Greenwich, or, still worse, upon assumed initial positions. All those published prior to 1880 were computed upon the Bessels spheroid of revolution, which has now been discarded in favor of Clarke's. Consequently all determinations published in the reports of this Survey prior to 1880 have been omitted from this compilation, since it is believed that an attempt to use them would only lead to error. The positions of the United States Coast and Geodetic Survey which are included in this publication are, first, those published since 1880, which are found almost entirely in southern New England and New York, and, second, a large number scattered widely over the country, which have been furnished to the United States Geological Survey in manuscript by the United States Coast and Geodetic Survey. They are upon Clarke's spheroid of revolution.

The work of this organization is of the highest order, bearing comparison with the best executed elsewhere in the world. For all purposes of mapmaking their determinations may be accepted without question of accuracy, however large may be the scale for which they are needed.

Astronomic determinations have been made by the best modern methods and instruments and by trained observers. The geodetic work has been done with a great variety of instruments, but in all cases with the best in use at the time. The results have been adjusted by least squares, and all determinations in the northeastern part of the country rest upon mean astronomical positions.

The abbreviation used for this organization in the following tables is "C. & G. S." The references are to its annual reports, abbreviated to "Rept.," with the last two figures of the date. Other references coupled with this authority are the first volume of the final report of the New Jersey State Survey, abbreviated to "Final Rept., Vol. 1," and Bulletin 122 of the United States Geological Survey, abbreviated to "Bull. 122." In cases where no reference is given it is to be understood that the data are not published in full. In such cases they can commonly be obtained by correspondence with the Superintendent of the United States Coast and Geodetic Survey.

UNITED STATES GEOLOGICAL SURVEY.

This organization has been engaged since 1882 in preparing a map of the country upon scales ranging from 1:250000 to 1:62500. For the primary control of these maps much triangulation has been executed. This is scattered widely over the country, and many thousand determinations have been made. To specify the localities would be to enumerate nearly every State in the Union. The extent of this triangulation and

the results accomplished are fully set forth in detail in Bulletin 122 of this organization.

This triangulation has been executed solely for the control of maps upon the above-mentioned scales, and, being simply a means toward a certain end, the extreme of accuracy has not been aimed at, but only such degree of accuracy as is required for the purpose. All the determinations are, however, believed to be of ample accuracy for the control of maps upon a scale of 1 mile to an inch.

Astronomic determinations have been made with the best instruments and the most approved methods. Triangulation has been done with a variety of instruments, from 6-inch theodolites, reading by vernier to ten seconds, up to 8-inch theodolites, reading by microscope to two seconds. Most of the work has been subjected to a least-square adjustment, although this refinement has not always been introduced.

All determinations are upon Clarke's spheroid.

In the tables the determinations of the United States Geological Survey are designated by the abbreviation "G. S." The reference given for nearly all of them is Bulletin 122 ("Bull. 122"), and for the rest Bulletins 49 and 70.

UNITED STATES LAKE SURVEY.

This organization was engaged for many years in a survey of the shores of the Great Lakes. The charts were controlled by geodetic work of high order, comparable with that of the United States Coast and Geodetic Survey. The determinations of positions are upon the shores of the Great Lakes and the St. Lawrence River, besides a belt of triangulation from the foot of Lake Erie to the head of Lake Michigan, and from the head of Lake Michigan southward in eastern Illinois nearly to the Ohio River.

The positions determined by this organization are published under the following title: "Professional Papers, Corps of Engineers, No. 24, Primary Triangulation, United States Lake Survey."

All positions determined are reduced to the Clarke spheroid.

In the following tables the Lake Survey is designated by the initials "L. S.," and the report above mentioned "Final Rept."

MISSISSIPPI RIVER COMMISSION.

This organization is engaged in a survey of that river, controlling it by triangulation, by means of which a large number of points have been located along its course, extending from southern Louisiana into Illinois. The accuracy of these determinations is amply sufficient for the scale of 1:20000, the largest scale upon which the maps have been issued. These determinations are upon the Clarke spheroid.

In the tables this organization is represented by the abbreviation "Miss. R. C.," and the references are, in the main, to its annual reports, which are published as a part of the reports of the Chief of Engineers, U. S. A.

MISSOURI RIVER COMMISSION.

The work of this organization is very similar to that of the Mississippi River Commission. Its determinations extend from the mouth of the river to its head, with one or two breaks in continuity. The positions are determined with ample accuracy for the control of maps upon a scale of 1 mile to 1 inch, and are reduced to the Clarke spheroid. They are indicated by the abbreviation "Mo. R. C.," and in most cases the references are to the annual reports of the Commission, which are published in connection with the reports of the Chief of Engineers, U. S. A.

UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.

This organization, under the directorship of Dr. F. V. Hayden, surveyed between 1873 and 1878 considerable areas in Colorado, Idaho, Utah, and Wyoming upon a scale of 4 miles to 1 inch. The triangulation executed for the control of this work is believed to be of sufficient accuracy for the control of maps upon larger scales, even up to 1 mile to an inch. The work was done with 8-inch theodolites, reading by vernier to ten seconds, and was adjusted by a graphic method. The positions were reduced to the Bessels spheroid. In the tables they are distinguished by "Hayden" as authority, and referred to the annual reports of that organization for the years 1876 and 1877.

UNITED STATES GEOGRAPHICAL AND GEOLOGICAL SURVEY OF THE ROCKY MOUNTAIN REGION.

This organization, popularly known as the Powell Survey, mapped between 1872 and 1878 the greater part of Utah and northern Arizona. The triangulation upon which the work rests was executed with 8-inch theodolites, reading by vernier to ten seconds, and was adjusted by least squares. While used for the control of maps upon a scale of 4 miles to 1 inch, it is believed to be of sufficient accuracy for maps of 1 inch to the mile. The results were reduced to the Clarke spheroid and are designated in the tables by "Powell," and reference is made to Bulletin 122 of the United States Geological Survey, in which they have been published.

UNITED STATES GEOGRAPHICAL SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN.

These surveys were carried on between the years 1867 and 1878 under the directorship of Maj. (then Lieut.) George M. Wheeler, of the Corps of Engineers, U. S. A. Prior to 1873 the work was done entirely by traverse. In later years it was controlled by triangulation. This was executed merely for the control of maps upon a scale of 4 miles to an inch. The instruments used were theodolites, reading by vernier to ten seconds, and the results were adjusted by least squares. They are reduced to the Bessels spheroid. In the tables the work of this organization is designated by "Wheeler," and reference is made to the annual reports of the organization.

Determinations in the Rocky Mountain region will be found to exhibit discrepancies of magnitude. These are due to two causes; one, the fact that certain organizations have used the Bessels spheroid and the others that of Clarke. The discrepancies due to this cause are, however, small in amount, ranging from one to three seconds of latitude and longitude. The other source of discrepancy is due to station errors. The station errors in this region are often large, owing to the high relief of the country. In certain cases they are known to be as great as a fourth of a mile, and further investigation will doubtless develop much larger ones. These can not be adjusted until numerous astronomical determinations, scattered widely over the country, have been connected by triangulation and mean results obtained to which all determinations may be reduced.

NEW YORK STATE SURVEY.

This organization, under the directorship of Mr. James T. Gardiner, executed a large amount of geodetic work in that State during the fourteen years of its existence, 1874 to 1887, inclusive. This work is of a high order, amply sufficient for maps upon almost any scale for which they may be required. The results are upon the Clarke spheroid.

The abbreviation used for this authority is "S. S.," and the reference is to the final report of the Survey.

LIST OF POSITIONS.

MAINE.

Name.	Latitude.	Longitude.	Authority.	Reference.
	44°-45° ° ' "	69°-70° ° ' "		
Bigelow	44 42 47.91	69 43 39.72	G. S.	Bull. 122.
Blin	07 14.72	40 52.26	C. & G. S.	
Bowman	32 31.67	41 56.60	G. S.	Do.
Costellow	02 52.89	46 07.01	C. & G. S.	
Hornbeam	28 32.84	57 05.58	G. S.	Do.
Houdlette	05 02.42	46 15.46	C. & G. S.	
Iron Hill	12 45.95	47 07.66	do	
Layton Hill	10 22.86	45 50.25	do	
Marco	35 21.72	38 49.84	G. S.	Do.
Maxwell	02 12.93	50 35.66	C. & G. S.	
Merserve	08 44.79	44 29.27	do	
Monks Hill	21 36.25	53 00.15	G. S.	Do.
Quaker	26 08.63	46 30.63	do	Do.
Telegraph Hill	10 28.12	44 43.49	C. & G. S.	
Winter	16 54.54	44 27.94	G. S.	Do.
	44°-45°	70°-71°		
Mount Blue	44 43 41.43	70 20 33.16	C. & G. S.	
Pisgah	18 22.67	01 27.66	do	Do.
Sabattus	08 37.83	04 43.74	do	Do.
	43°-44°	69°-70°		
Cushman	43 58 44.04	69 40 46.62	do	
Edgecomb	57 13.76	36 18.53	do	
Great Hill	53 46.92	51 14.54	do	
Haggett	59 44.31	36 18.62	do	
Hodgkins	58 43.48	48 48.18	do	
Norwood	59 54.33	33 56.38	do	
Sprague	58 31.90	53 64.89	do	
	43°-44°	70°-71°		
Adams	43 52 53.95	70 23 28.51	G. S.	Do.
Agamenticus	13 24.63	41 32.91	C. & G. S.	Do.
Eauneg Beg	23 03.18	47 07.26	G. S.	Do.
Biddeford:				
New slate spire	29 38.00	27 40.80	do	
Congregational church spire	29 34.20	27 26.59	do	
Tall spire	29 31.80	27 32.64	C. & G. S.	
Baptist church spire	29 40.50	27 30.53	do	
Billings Hill	04 03.13	41 30.66	do	
Bradbury	54 08.01	10 56.36	do	
Cape Elizabeth:				
West light-house (1874)	33 51.57	12 11.04	do	
East light-house (1874)	33 58.15	12 02.43	do	
East Sister	04 06.48	40 01.04	do	
Farnham	30 05.77	55 47.06	G. S.	Do.
Fort Sullivan	04 32.64	44 00.94	C. & G. S.	
Fort Washington	04 26.21	44 27.57	do	
Freeport:				
Church	51 28.13	06 12.86	do	
Dark spire	51 45.53	06 03.35	do	
Frost Hill	09 45.00	47 23.93	do	
Gorham	40 50.60	26 49.96	G. S.	Do.
Groveville church spire	39 52.90	31 10.60	do	
Kennebunk:				
Town clock	23 16.70	32 15.90	do	
Spire	23 13.10	32 15.10	do	
Kittery Point	04 44.60	42 52.72	C. & G. S.	
Mount Independence	45 33.75	19 14.34	do	Do.
Mount Pleasant	01 36.69	59 21.94	do	
Munjoy	39 55.64	14 55.64	do	Do.
Ossipee	35 18.87	44 27.66	do	Do.
Portland Head light-house	37 23.51	12 30.23	do	

MAINE—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	43°-44° ° / "	70°-71° ° / "		
Rattlesnake, wooded summit.....	43 58 01.10	70 29 10.90	G. S	Bull. 122.
Saco, church	30 02.96	26 35.06	C. & G. S	
Sawyer	44 41.00	45 13.06	G. S	
Sebago Hill, tall dead tree	50 40.20	43 48.00	do	Do.
Sebago Bald Hill, pine tree	51 53.30	41 57.30	do	
Seward	04 11.19	40 44.91	C. & G. S	
Tare Shirt	19 15.90	49 20.85	G. S	
West Sister	03 42.98	40 21.62	C. & G. S	
Whale Back	03 31.59	41 49.26	do	
Light-house (1878)	03 31.80	41 48.56	do	
Light-house (1850)	03 31.70	41 49.05	do	
Wood Island	03 46.23	41 52.34	do	
White Island	03 35.42	41 20.10	do	
Windham, church	47 50.70	25 26.60	G. S	
Wood Island light-house	27 24.70	19 46.25	C. & G. S	
Wooded Knob	54 16.00	39 18.60	G. S	
Yarmouth:				
Yellow spire	48 12.70	11 47.07	C. & G. S	
White spire	47 58.28	11 01.80	do	
York	46 43.45	11 08.88	do	
	42°-43°	70°-71°		
Isle of Shoals, Hog Island	42 59 14.86	70 36 50.28	do	

NEW HAMPSHIRE.

	44°-45° ° / "	71°-72° ° / "		
Agassiz	44 15 58.17	71 40 38.05	G. S	Bull. 122.
Carrigain	05 37.23	26 50.87	do	
Ingalls	28 16.90	02 22.00	C. & G. S	
Iron Mountain	08 03.02	14 22.65	G. S	Do.
Kearsarge	06 21.06	05 41.12	do	Do.
Lafayette	09 38.92	38 41.66	C. & G. S	Do.
Moat	02 35.70	12 55.18	G. S	Do.
Moriah	20 24.90	07 55.40	C. & G. S	
Mount Washington:				
Chimney	16 14.44	18 11.49	do	Do.
Tower	16 14.06	18 13.65	do	Do.
Prospect Hill	27 05.88	34 16.80	G. S	Do.
South Baldface	13 51.46	04 42.45	do	Do.
Starr King	26 04.50	25 59.80	C. & G. S	Do.
	43°-44°	70°-71°		
Blunt Island	43 03 25.95	70 43 53.46	do	
Boatswain Hill	03 57.17	43 26.43	do	
Clark Island	04 34.36	43 28.63	do	
Clark Island, 2	04 37.30	43 28.50	do	
Fort Constitution	04 18.06	42 34.67	do	
Foss Rye	00 45.81	44 21.28	do	
Frost Hill	03 35.25	43 36.27	do	
Frost Point	03 11.01	43 10.86	do	
Garrison	12 34.63	52 12.71	do	
Jerrys Fort	03 26.92	42 45.66	do	
Newcastle	03 37.10	43 20.49	do	
Portsmouth Harbor:				
Northwest base (1842)	02 55.73	43 14.19	do	
Newcastle light-house (1850-1878)	04 16.10	42 32.92	do	
Pulpit Rock	01 58.54	43 08.31	do	
Salter Island	03 57.00	44 49.78	do	
Stratham Hill	02 22.53	53 26.26	do	
Tower	04 13.70	42 45.68	do	
Wentworth Height	03 41.46	44 29.38	do	
	43°-44°	71°-72°		
Chocorua	43 57 16.17	71 16 26.36	G. S	Rept. '85.
Patuccawa	07 13.69	11 51.32	C. & G. S	
	43°-44°	72°-73°		
Hanover	43 42 15.20	72 17 07.95	do	
Observatory Hill, New Dartmouth College.	42 19.79	17 08.07	do	
	42°-43°	70°-71°		
Great Boars Head	42 55 05.43	70 47 45.93	do	
Hampton	56 33.94	49 37.92	do	
Hampton Falls	54 44.37	53 51.88	do	
Little Boars Head	57 28.88	46 33.80	do	
Seabrook	52 29.59	49 06.55	do	

NEW HAMPSHIRE—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43°	71°-72°		
	° / "	° / "		
Philbrick.....	42 56 59.66	71 07 14.70	C. & G. S.....	
Unkonoonuc.....	58 59.86	35 19.38	do.....	
	42°-43°	72°-73°		
Monadnock.....	42 51 41.17	72 06 30.78	do.....	

VERMONT.

	44°-45°	72°-73°		
	° / "	° / "		
Potato Hill.....	44 07 13.69	72 56 12.04	C. & G. S.....	
	44°-45°	73°-74°		
	° / "	° / "		
Apple Tree Point.....	44 29 50.37	73 16 27.77	do.....	
Barber Hill.....	18 10.20	15 33.44	do.....	
Comstock Hill.....	23 26.66	15 40.46	do.....	
Fields Hill.....	12 30.92	13 59.58	do.....	
Head.....	49 49.65	20 35.59	do.....	
Hen Island.....	49 22.00	16 20.26	do.....	
Hill.....	52 42.35	20 01.76	do.....	
Island La Motte light-house.....	54 23.46	20 38.16	do.....	
Juniper Island.....	26 57.70	16 39.23	do.....	
Sawyer Island.....	39 00.63	21 21.05	do.....	
Saxton Point.....	23 48.44	16 45.11	do.....	
Smith.....	00 34.83	22 22.85	do.....	
Snake Mountain tower.....	03 41.91	16 52.11	do.....	
Whitford.....	04 16.32	17 31.84	do.....	
Windmill Point light-house.....	58 54.65	20 32.26	do.....	
	43°-44°	72°-73°		
	° / "	° / "		
Ascutney.....	43 26 46.74	72 27 08.48	do.....	
Colton.....	57 10.24	22 03.21	do.....	
Gile.....	47 20.78	21 07.33	do.....	
Glebe.....	11 20.23	45 41.10	do.....	
Goshen.....	49 46.72	58 16.87	do.....	
Killington.....	36 17.50	49 14.28	do.....	
Rochester.....	52 01.29	44 55.15	do.....	
Sty'les.....	16 25.20	56 18.41	do.....	
West Hawks.....	22 04.86	34 50.60	do.....	
	43°-44°	73°-74°		
	° / "	° / "		
Fletcher.....	43 59 27.01	73 18 41.26	do.....	
Forbes.....	29 28.26	19 46.83	do.....	
French.....	47 55.50	21 43.16	do.....	
Herrick (1882).....	33 45.67	05 58.07	do.....	
Landon.....	47 41.04	11 05.51	do.....	
Mount Defiance.....	49 53.15	24 25.45	do.....	
Mount Equinox.....	09 57.98	07 02.71	do.....	
Northeast.....	26 07.49	10 02.75	do.....	
Poultney, Baptist church.....	30 57.02	14 16.17	do.....	
Rupert.....	18 28.23	12 00.46	G. S.....	
Sisson Hill.....	52 59.72	19 50.60	do.....	
Wilson.....	43 17.55	20 45.57	do.....	
	42°-43°	72°-73°		
	° / "	° / "		
Chesterfield.....	42 53 23.15	72 26 23.11	do.....	
Halifax.....	46 30.79	43 27.67	C. & G. S.....	
Haystack.....	54 50.09	55 10.55	do.....	
White Hill.....	59 17.68	48 18.61	do.....	

MASSACHUSETTS.

	42°-43°	70°-71°		
	° / "	° / "		
Abbott Rock, stone beacon.....	42 31 49.48	70 51 46.34	C. & G. S.....	Rept. '85.
Amesbury Mills, tall white spire.....	51 21.38	55 58.58	do.....	Do.
Andrew Point.....	40 58.98	37 46.80	do.....	Do.
Annisquam Harbor, light-house.....	39 43.02	40 55.29	do.....	Do.
Annisquam, pole on rock.....	39 26.92	40 39.62	do.....	Do.
Apple Island, flag.....	21 31.55	59 32.43	do.....	Do.
Atlantic House, chimney.....	16 03.02	50 53.05	do.....	Do.
Bailey Wharf.....	48 42.94	51 56.55	do.....	Do.
Baker Island, light-house.....	32 11.53	47 11.22	do.....	Do.
Baker Hill.....	14 35.94	54 28.47	do.....	Do.
Ballard.....	27 17.56	59 32.57	do.....	Do.
Barrel Beacon.....	19 22.27	55 09.18	do.....	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			70°-71°				
	°	'	"	°	'	"		
Bartlett	42	50	04.46	70	55	23.74	C. & G. S.	Rept. '85.
Batt Hill		52	15.86		53	32.60	do	Do.
Beacon Hill, 1		36	24.94		38	43.01	do	Do.
Beacon Hill, 2		36	11.74		38	38.64	do	Do.
Beacon Hill, magnetic station		36	22.79		38	46.85	do	Do.
Belle Isle		22	57.30		59	56.35	do	Do.
Beverly:								
Powder house		33	12.60		52	33.13	do	Do.
Tall spire, with turrets		32	51.06		52	43.52	do	Do.
Beverly Point, flag in tree		32	59.04		54	15.46	do	Do.
Beverly rocks		33	58.78		50	14.98	do	Do.
Bluff Head, flag		22	03.82		58	04.53	do	Do.
Black Rock		16	08.56		49	28.42	do	Do.
Bolles		35	05.95		47	35.44	do	Do.
Bonney		03	10.50		52	34.01	do	Do.
Boston, light-house		19	40.74		53	26.18	do	Do.
Boulder, west of Salem Turnpike		30	21.92		56	07.38	do	Do.
Bowditch Ledge, beacon		32	25.38		48	43.19	do	Do.
Brant		05	17.32		38	28.70	do	Do.
Breakwater, east end, spindle		37	27.31		17	34.06	do	Do.
Brookhouse House		29	08.56		53	13.76	do	Do.
Brown Hill		36	45.69		50	49.98	do	Do.
Bunkin Island, flag		16	51.86		54	02.85	do	Do.
Burnham Brown, flag		39	32.00		49	25.88	do	Do.
Butler Hill		39	29.50		40	18.33	do	Do.
Byfield church, square tower		44	19.04		55	53.81	do	Do.
Cape Ann, north light-house		38	21.25		34	31.05	do	Do.
Cape Ann, south light-house		38	12.82		34	31.78	do	Do.
Cape Cod, or Highlands of Truro, light-house.		02	23.16		03	39.83	do	Do.
Carolina Hill		06	58.52		43	52.85	do	Do.
Cat Hill		13	19.18		45	20.32	do	Do.
Cat Island:								
East rock		30	32.61		48	45.00	do	Do.
Flagstaff		30	43.52		48	55.42	do	Do.
Choate		39	55.52		45	40.80	do	Do.
Church spire, summer house		28	55.14		53	03.45	do	Do.
Clift		09	29.08		45	05.26	do	Do.
Coddon		30	59.17		51	17.52	do	Do.
Coney Island, flag		31	42.89		50	14.78	do	Do.
Cohasset church		14	35.63		48	14.02	do	Do.
Crane Neck		46	13.67		58	31.75	do	Do.
Crow Point		15	41.98		53	46.47	do	Do.
Crusoe House, flagstaff		26	10.65		58	07.58	do	Do.
Danvers Insane Asylum, tower		34	51.74		58	30.82	do	Do.
Danvers New Mills, tall spire		33	20.70		55	30.55	do	Do.
Danvers Plain, tall spire		34	03.32		56	18.26	do	Do.
Deer Island		21	01.28		57	30.99	do	Do.
Beacon		20	23.44		57	18.41	do	Do.
Flag		21	01.24		57	30.95	do	Do.
Hospital cupola		21	12.39		57	53.15	do	Do.
Dexter Point		32	53.80		50	44.26	do	Do.
Derby Wharf, light-house		30	59.91		53	02.54	do	Do.
Dodge Hotel, cupola		32	02.86		53	49.30	do	Do.
Dogtown, Methodist church		38	04.86		40	33.09	do	Do.
Dread Ledge, beacon		27	23.19		53	43.54	do	Do.
Dummer Academy		45	16.29		53	59.58	do	Do.
Duxbury, astronomic station		02	55.18		40	10.96	do	Do.
Eagle Island		31	31.21		48	49.24	do	Do.
East Duxbury, belfry		02	08.10		40	24.05	do	Do.
Eastern Point, light-house		34	49.14		39	53.90	do	Do.
East Weymouth, church		12	50.40		55	31.08	do	Do.
Eaton Hill		15	44.08		59	53.43	do	Do.
Egg Rock		26	00.40		53	53.34	do	Do.
Light-house		26	00.76		53	54.02	do	Do.
Essex, powder house		38	19.16		47	18.24	do	Do.
Essex, red-top church		37	59.96		46	53.16	do	Do.
Fawn Beacon		21	17.58		56	32.87	do	Do.
Florence, Cosmian Hall clock tower		20	09.26		40	26.55	do	Do.
Folly Hill		33	59.12		54	48.20	do	Do.
Fort Lee		31	54.71		52	28.94	do	Do.
Fort Pickering, light-house		31	35.57		52	01.07	do	Do.
Fort Warren, west gable of house		19	13.10		55	42.40	do	Do.
Gallop Island, flag		19	37.30		56	21.48	do	Do.
Gallop Island, 2		19	37.97		56	23.16	do	Do.
George Island		19	11.16		55	42.32	do	Do.
Gloucester:								
Church		37	00.46		39	25.66	do	Do.
Universalist church		36	47.66		40	00.14	do	Do.
Grape Island, flag		16	07.28		55	27.21	do	Do.
Graves		21	53.66		52	12.61	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			70°-71°				
	°	'	"	°	'	"		
Great Aquavitæ	42	31	34.58	70	51	28.24	C. & G. S.	Rept. '85.
Great Brewster		20	01.96		53	45.18	do	Do.
Great Brewster, 2		20	01.68		53	45.22	do	Do.
Great Haste		32	05.29		50	32.51	do	Do.
Great Misery, flag		32	50.20		47	49.23	do	Do.
Great Quincy		16	29.03		57	06.87	do	Do.
Green Island, flag		21	11.17		53	33.01	do	Do.
Green Island, 2		21	11.14		53	33.02	do	Do.
Grose		09	53.90		52	43.52	do	Do.
Grover Cliff		23	22.79		58	08.65	do	Do.
Gurnet		00	11.40		36	06.05	do	Do.
Gurnet, light-house		00	12.30		36	04.03	do	Do.
Halfway Rock, beacon		30	09.38		46	31.40	do	Do.
Hangman Ledge, beacon		17	44.75		57	39.22	do	Do.
Hardy Rock, beacon		32	11.36		48	01.62	do	Do.
Hatch		08	08.48		42	11.36	do	Do.
Hayden's Hotel		15	10.37		46	20.13	do	Do.
Highland		01	41.33		02	47.49	do	Do.
Hingham :								
Church with clock		14	34.32		53	29.43	do	Do.
Great Plains church		12	38.35		53	04.50	do	Do.
Old Colony house, cupola		14	51.75		52	22.62	do	Do.
Old church		14	26.68		53	14.96	do	Do.
Hull :								
Oregon House, cupola		18	12.14		54	47.44	do	Do.
Steamboat Hotel, cupola		18	16.26		55	08.29	do	Do.
Hospital Point, light-house		32	47.60		51	23.29	do	Do.
Indian Hill, flagstaff		47	03.22		56	54.40	do	Do.
Ipswich :								
Beacon		41	07.56		45	59.91	do	Do.
Light-house		41	06.81		46	07.32	do	Do.
Tall dark spire		40	53.18		50	11.70	do	Do.
Town farm		43	03.92		50	52.09	do	Do.
Jones		09	28.84		50	01.88	do	Do.
Kettle Island		34	01.26		43	22.00	do	Do.
Kimball's house, center chimney		20	19.12		53	26.75	do	Do.
King Oak Hill, pole		13	38.94		56	25.32	do	Do.
Lane Cove, white spire		40	41.55		39	15.88	do	Do.
Legg Hill		29	23.30		53	30.83	do	Do.
Lewis		08	09.45		43	13.69	do	Do.
Little Aquavitæ, pole		31	34.78		51	13.10	do	Do.
Little Haste, beacon		32	07.71		50	35.95	do	Do.
Little Nahant		26	13.27		55	52.09	do	Do.
Little Oldtown		46	24.87		50	32.24	do	Do.
Londoner Beacon		38	06.26		33	59.33	do	Do.
Long Island Head, light-house		19	48.13		57	24.12	do	Do.
Long Island Hotel, cupola		19	27.40		57	53.39	do	Do.
Long Island, south end		18	39.52		58	37.16	do	Do.
Long Island, south end, 2		18	39.60		58	36.88	do	Do.
Long Point :								
Light-house		01	59.47		10	09.01	do	Do.
Schoolhouse		01	21.71		10	55.15	do	Do.
Lovell Island		19	48.60		55	50.36	do	Do.
Lufkin Hill		38	16.08		44	40.86	do	Do.
Lynn, east church, green tower		28	07.12		56	16.41	do	Do.
Lynn :								
High rock		28	04.96		56	52.10	do	Do.
West church turret		27	45.71		57	37.00	do	Do.
Manchester, church, with dark spire		34	30.28		46	20.82	do	Do.
Manning Hill		42	30.26		48	23.32	do	Do.
Marblehead :								
Black-top church		30	25.66		50	54.11	do	Do.
Light-house		30	19.76		50	03.02	do	Do.
Neck		29	46.94		50	29.04	do	Do.
Rock, beacon		30	11.95		49	34.48	do	Do.
Marshfield cupola		09	25.12		44	33.34	do	Do.
Milk Island		37	41.64		35	31.80	do	Do.
Minot Ledge light-house		16	11.16		45	34.71	do	Do.
Moonhead, 1		18	22.20		59	23.06	do	Do.
Moonhead, 2		18	22.04		59	23.13	do	Do.
Morrill		49	15.65		51	06.50	do	Do.
Mouth of Merrimac, chimney of house		49	13.63		49	18.14	do	Do.
Mount Hope		11	34.97		49	18.00	do	Do.
Nahant, hotel cupola		25	09.20		54	19.84	do	Do.
Nantasket		18	15.69		54	20.20	do	Do.
Nantucket Cliff, range beacon		17	37.96		06	24.12	do	Do.
Newbury :								
Belleville church		49	06.77		53	24.84	do	Do.
Upper green church		47	58.56		51	46.19	do	Do.
Newburyport :								
Academy		48	31.79		52	28.89	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			70°-71°				
	°	'	"	°	'	"		
Newburyport—Continued.	42	48	49.26	70	51	28.43	C. & G. S.	Rept. '85.
Beacon on north pier	42	48	49.26	70	51	28.43	do	Do.
Federal Street church	48	30	56	51	59	57	do	Do.
Harris Street church	48	31	71	52	23	74	do	Do.
Newburyport light-house	48	54	76	49	10	42	do	Do.
Newburyport Unitarian church	48	38	42	52	19	21	do	Do.
Neptune House, flagstaff	25	43	48	58	46	76	do	Do.
Nix's Mate	19	53	35	56	40	94	do	Do.
North Gooseberry Island	31	35	97	47	39	19	do	Do.
North Marshfield Unitarian church spire.	08	30	15	44	29	46	do	Do.
North Pettick Island	18	06	28	55	47	57	do	Do.
North Pettick Island, 2	18	06	32	55	47	73	do	Do.
North Weymouth, church	13	46	46	56	42	94	do	Do.
Ocean House, cupola	28	53	73	52	33	64	do	Do.
Oldtown	46	07	58	51	00	90	do	Do.
Oldtown church spire	47	58	49	51	46	19	do	Do.
Orne	30	10	26	57	54	45	do	Do.
Outer Brewster, 2	20	29	33	52	41	21	do	Do.
Ox Pasture Hill	44	17	08	52	55	00	do	Do.
Paine Hill, observatory	14	01	56	59	42	96	do	Do.
Parker Hill	13	45	60	46	49	55	do	Do.
Pamet	00	14	91	04	52	68	do	Do.
Pig Rock beacon	16	44	04	56	22	65	do	Do.
Pincin Hill	11	21	07	46	45	42	do	Do.
Plum Island, 1	46	37	02	48	17	72	do	Do.
Plum Island, 2	44	27	80	47	33	78	do	Do.
Plum Island magnetic station	47	59	94	48	49	34	do	Do.
Plymouth light-house	00	12	30	36	04	03	do	Do.
Point Allerton beacon	18	47	08	53	00	29	do	Do.
Point Allerton flag	18	37	12	52	59	36	do	Do.
Point Shirley, foundry chimney	21	31	80	58	20	22	do	Do.
Poole Hill	39	24	69	38	05	77	do	Do.
Powow	51	57	01	56	18	81	do	Do.
Powder Point	02	49	15	39	10	75	do	Do.
Prospect:								
Hingham	11	34	69	51	27	16	do	Do.
Rowley	42	19	15	53	33	13	do	Do.
Provincetown	03	08	45	11	20	53	do	Do.
Academy	03	09	78	11	14	50	do	Do.
Baptist church belfry	03	27	45	10	39	74	do	Do.
Methodist church belfry	03	06	52	11	17	82	do	Do.
Methodist Centenary church	02	52	44	11	26	78	do	Do.
New Universalist church spire	03	02	08	11	19	94	do	Do.
Orthodox church spire	03	04	03	11	17	61	do	Do.
Schoolhouse	02	41	17	11	36	90	do	Do.
Quincy:								
Bent Point church	14	45	75	58	31	97	do	Do.
Black-top church	15	00	66	59	49	90	do	Do.
Race	04	50	41	12	26	65	do	Do.
Race Point light-house	03	44	56	14	36	99	do	Do.
Railcut Hill	37	42	87	38	58	40	do	Do.
Rainsford Island:								
Flag	18	46	91	57	07	12	do	Do.
Flagstaff	18	46	83	57	07	41	do	Do.
Rockland church	07	48	98	54	56	63	do	Do.
Rockland House, cupola	15	56	90	51	10	05	do	Do.
Rockport, red-top church	39	28	80	37	09	70	do	Do.
Rowley:								
Church spire with turrets	42	59	02	52	42	38	do	Do.
Marsh	44	37	76	50	16	33	do	Do.
Sagamore Head	16	24	46	51	50	04	do	Do.
Salem:								
South church, corner Cambridge and Chesnut streets.	31	12	02	53	59	36	do	Do.
Howard street church	31	28	12	53	34	04	do	Do.
Salisbury church	50	33	98	51	38	96	do	Do.
Salisbury Beach	50	49	10	49	03	44	do	Do.
Salisbury Marsh	52	18	68	49	14	68	do	Do.
Salt Island, flag	37	11	38	37	26	60	do	Do.
Salvage	40	20	24	34	05	94	do	Do.
Scituate	14	14	65	49	51	23	do	Do.
Light-house	12	17	32	42	58	74	do	Do.
Unitarian church	12	00	69	45	22	19	do	Do.
South Abington	04	49	67	56	34	24	do	Do.
South Danvers, tall spire	31	35	38	55	40	55	do	Do.
South Pettick Island	17	23	82	56	51	66	do	Do.
Spectacle Island, flag	19	38	90	59	16	66	do	Do.
Sprague	00	17	90	58	00	11	do	Do.
Standish	00	50	77	40	58	21	do	Do.
Monument	00	50	24	40	57	66	do	Do.
Stout	04	09	52	07	32	83	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			70°-71°				
	°	'	"	°	'	"		
Straitsmouth light-house.....	42	39	44.37	70	35	19.15	C. & G. S.	Rept. '85.
Strawberry Hill, barn.....		17	22.52		52	49.47	do	Do.
Studley.....		08	13.49		48	07.38	do	Do.
Summerhouse on high rock.....		28	05.06		56	48.86	do	Do.
Swampscott, church.....		28	06.14		54	58.40	do	Do.
Ten Pound Island light-house.....		36	06.66		39	57.58	do	Do.
Thatcher Island.....		38	10.94		34	46.28	do	Do.
Thayer Hill, yellow house chimney ..		13	51.49		58	10.55	do	Do.
Thompson.....		36	41.92		43	49.16	do	Do.
Tinker Island, pole on house.....		28	57.71		50	07.28	do	Do.
Turkey Hill.....		14	25.68		51	14.22	do	Do.
Twopenny Loaf, flag.....		39	36.80		43	08.84	do	Do.
Upper Harbor, inner beacon.....		48	40.70		51	59.70	do	Do.
Do.....		48	41.70		51	55.25	do	Do.
Ware Hill, flagstaff.....		30	40.60		54	32.79	do	Do.
Webster (Hon. D.):								
West chimney on house.....		03	48.26		40	47.07	do	Do.
Flagstaff.....		04	39.21		40	13.77	do	Do.
Weeks, house chimney.....		20	21.21		53	49.02	do	Do.
West Duxbury, Unitarian church steeple.....		02	06.65		41	33.44	do	Do.
West Salisbury:								
Powderhouse.....		51	22.08		54	51.36	do	Do.
Church.....		50	39.64		55	01.21	do	Do.
West Scituate, church.....		09	28.33		51	10.23	do	Do.
Weymouth Great Hill.....		14	59.38		56	33.50	do	Do.
White.....		07	05.94		41	24.59	do	Do.
White Hill.....		12	52.47		58	39.30	do	Do.
Winthrop Head.....		22	04.07		58	06.04	do	Do.
Winthrop Head, 2.....		22	04.36		58	08.25	do	Do.
Wood End light-house.....		01	16.61		11	38.49	do	Do.
Woods Hotel.....		45	23.87		48	15.60	do	Do.
Woodward Hill, flag.....		36	59.74		42	05.96	do	Do.
	42°-43°			71°-72°				
Adams School, flagstaff.....	42	21	57.86	71	01	59.08	do	Do.
Agassiz Museum.....		22	44.52		06	56.04	do	Do.
Alum Pond.....		01	14.51		45	45.24	do	Do.
Ashland.....		16	37.41		06	52.84	do	Do.
Asnebumskit.....		18	05.11		53	50.81	do	Do.
Bald Hill.....		02	44.22		42	35.59	do	Do.
Battery Wharf.....		22	01.32		02	59.22	do	Do.
Bay State Iron Works.....		20	24.77		02	22.31	do	Do.
Bay State Steam Engine Works.....		21	45.52		02	09.69	do	Do.
Bell Tower.....		17	50.78		06	30.83	do	Do.
Bird Island.....		21	22.80		01	15.97	do	Do.
Beacon.....		21	18.06		01	15.96	do	Do.
Blind Asylum.....		20	07.04		02	32.86	do	Do.
Blue Hill.....		12	43.68		06	52.71	do	Do.
Boston:								
State prison cupola.....		22	28.23		04	08.84	do	Do.
Berkley street, yellow spire.....		20	44.13		04	15.42	do	Do.
Hanover street, brick church.....		21	49.90		03	17.44	do	Do.
Hollis street church.....		20	59.42		03	53.15	do	Do.
Jail, cupola.....		21	43.26		04	14.44	do	Do.
Catholic cathedral statue.....		20	12.67		04	25.14	do	Do.
Neck, dark spire with cross.....		20	26.77		04	25.27	do	Do.
St. Mary's church, north spire.....		21	54.82		03	29.69	do	Do.
State House.....		21	29.59		03	51.04	do	Do.
Boxboro.....		29	29.94		31	39.96	G. S.	Bull. 122.
Boylston School, cupola.....		21	21.51		03	09.02	C. & G. S.	Rept. '85.
Breed Island.....		23	28.04		00	30.28	do	Do.
Brick factory.....		23	45.12		04	12.89	do	Do.
Near Mystic River, cupola.....		24	32.76		05	27.07	do	Do.
Brighton:								
East church.....		20	57.83		09	13.03	do	Do.
West church, with clock.....		20	56.25		09	20.29	do	Do.
Brookline, Dr. Pierce's church.....		19	38.18		07	52.48	do	Do.
Brown Hill.....		37	00.54		50	41.31	G. S.	Bull. 122.
Bunker Hill:								
Catholic church.....		22	53.34		04	00.70	C. & G. S.	Rept. '85.
Monument.....		22	35.05		03	40.56	do	Do.
Burnt Swamp.....		01	08.36		22	54.53	do	Do.
Cambridge:								
Baptist church.....		22	34.42		07	07.71	do	Do.
Gas works chimney.....		22	24.35		07	36.78	do	Do.
Observatory, center of dome.....		22	53.49		07	43.88	do	Do.
Observatory, meridian mark.....		25	47.43		07	43.52	do	Do.
Observatory, west transit.....		22	53.48		07	44.48	do	Do.
Unitarian church.....		22	28.70		07	10.78	do	Do.
Cambridgeport:								
Flagstaff near engine house.....		21	45.58		05	15.64	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			71°-72°				
	°	'	"	°	'	"		
Cambridgeport—Continued.								
Observatory dome	42	21	19.06	71	06	35.85	C. & G. S.	Rept. '85.
Redoubt, flagstaff		21	23.89		06	17.21	do	Do.
Universalist church		21	47.52		06	00.88	do	Do.
Captain John's Hill		16	15.67		07	47.00	do	Do.
Carpet-cleaning factory		21	16.62		04	39.93	do	Do.
Castle Island		20	19.26		00	45.65	do	Do.
Center		21	09.74		02	46.38	do	Do.
Central Wharf cupola		21	32.54		03	05.21	do	Do.
Chelsea:								
Bridge		22	56.55		02	55.67	do	Do.
Brown tower		23	28.98		01	46.40	do	Do.
Church		24	32.98		00	26.28	do	Do.
Dark spire cross		23	40.47		01	54.68	do	Do.
Tall dark spire		23	30.56		02	16.90	do	Do.
White spire, martin hole windows		23	24.55		02	19.91	do	Do.
White spire, three tiers windows		23	36.20		02	16.13	do	Do.
White spire, with clock		23	27.33		02	18.18	do	Do.
Chandler Hill		16	15.20		47	11.43	do	Do.
Charles River tripod		21	09.41		07	00.28	do	Do.
Charlestown, brick church cross		22	21.96		03	48.32	do	Do.
Cloverdon		22	47.54		07	18.42	do	Do.
Observatory (zenith telescope)		22	46.29		07	17.60	do	Do.
Coal shed, flagstaff		23	06.56		02	39.20	do	Do.
Commercial Point, wharf, flag		18	00.28		02	38.24	do	Do.
Corey		20	33.38		08	02.20	do	Do.
Cunard Wharf, flagstaff		21	49.98		02	27.98	do	Do.
Dorchester:								
Church, with clock		18	29.60		03	45.81	do	Do.
Dr. Codman's church		17	26.85		04	18.00	do	Do.
Heights		20	03.43		02	35.91	do	Do.
East Boston		22	53.13		02	11.74	do	Do.
Brick church, dark spire		22	26.77		02	21.89	do	Do.
Dry dock, post		21	44.76		01	54.81	do	Do.
Elevator		21	47.59		02	15.51	do	Do.
Granite church, dark spire		22	16.06		02	28.44	do	Do.
Iron works, chimney		22	55.76		01	48.44	do	Do.
Point, flag		21	58.24		01	44.75	do	Do.
Reservoir, 2		22	52.56		02	09.91	do	Do.
Shipyard, east wharf, post		21	50.12		01	41.59	do	Do.
Eastern avenue, wharf, post		21	50.10		02	56.18	do	Do.
East Cambridge:								
Church near court-house		22	11.46		04	50.78	do	Do.
Court-house, cupola		22	11.95		04	48.56	do	Do.
Edgeworth Mills (round chimney)		25	01.38		04	30.87	do	Do.
Faneuil Hall		21	36.38		03	23.70	do	Do.
Farm schoolhouse, southeast gable		19	05.26		00	27.55	do	Do.
Fay Mountain		14	23.79		37	42.54	G. S.	Bull. 122.
Fitchburg:								
Depot		22	00.36		03	41.64	C. & G. S.	Rept. '85.
Roundhouse		22	23.43		04	10.02	do	Do.
Flagstaff, corner Dorchester street and turnpike.		19	47.62		03	26.50	do	Do.
Forbes		15	27.87		01	38.94	do	Do.
Fort Hill, wharf, post		21	15.74		03	05.16	do	Do.
Fort Independence, flagstaff		20	18.90		00	44.92	do	Do.
Foster Wharf, post		21	21.15		03	01.36	do	Do.
Foxboro:								
Baptist church, white spire		03	51.18		15	05.06	do	Do.
Orthodox church, dark spire		03	54.65		15	08.34	do	Do.
Fulton Wire Works, south chimney		20	08.04		03	29.56	do	Do.
Gambrel, roof, northeast gable		22	18.38		03	26.45	do	Do.
Gas works:								
Near Malden Bridge		23	18.75		04	29.70	do	Do.
North end of Boston		22	01.90		03	28.38	do	Do.
Ventilator		20	50.28		03	27.18	do	Do.
Glass works, east gable		22	22.65		04	41.86	do	Do.
Governors Island		21	08.31		00	39.03	do	Do.
Governors Island, 2		21	09.10		00	42.86	do	Do.
Governors Island, 3		21	08.84		00	41.12	do	Do.
Grand Junction, wharf		21	47.39		02	22.93	do	Do.
Grays Wharf, long brick building		22	09.48		03	16.38	do	Do.
Groton Hill		36	38.28		33	28.31	G. S.	Bull. 122.
Guide post, west end of milldam		20	55.63		05	51.00	C. & G. S.	Rept. '85.
High service		19	31.35		05	42.30	do	Do.
Hog Island tripod		23	39.16		00	39.69	do	Do.
Holmes factory		22	45.76		03	29.36	do	Do.
Holt		38	28.03		06	24.87	do	Do.
House on hill		34	51.96		59	02.35	G. S.	Bull. 122.
Hyde Park Catholic church		15	18.56		07	23.15	C. & G. S.	Do.
India wharf:								
Cupola		21	29.10		02	59.70	do	Rept. '85.
Post		21	28.04		02	59.09	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43° ° ' "	71°-72° ° ' "		
Iron smokestack.....	42 23 14.06	71 02 26.10	C. & G. S.	Rept. '85.
James and Pope's timber dock.....	20 32.51	02 39.68	do	Do.
Jerusalem.....	15 20.73	08 49.00	do	Do.
Jewish cemetery.....	15 35.37	09 15.07	do	Do.
Joe Rock.....	01 52.99	24 17.24	do	Do.
Lawrence School, cupola.....	20 28.78	03 12.88	do	Do.
Lewis Wharf, cupola.....	21 47.44	03 00.02	do	Do.
Lincoln Wharf, post.....	21 57.72	02 58.15	do	Do.
Long Wharf.....	21 37.65	02 53.75	do	Do.
Building, lightning rod.....	21 37.08	02 57.46	do	Do.
2, post.....	21 36.45	02 53.54	do	Do.
Loring's machine-shop wharf.....	20 31.60	02 02.70	do	Do.
Lowell:				
Depot, flagstaff.....	21 53.81	03 47.12	do	Do.
Draw, flagstaff.....	22 05.14	04 08.40	do	Do.
Roundhouse.....	22 09.74	04 23.39	do	Do.
Machine shop, tall chimney, on ridge-pole.....	20 28.60	03 59.10	do	Do.
Malden:				
Bridge.....	23 11.41	04 13.50	do	Do.
Bridge, yellow house, chimney at tall gable.....	23 34.58	04 09.58	do	Do.
Church, tall spire.....	25 38.84	04 01.56	do	Do.
Yellow spire.....	25 38.75	04 01.44	do	Do.
Mansfield, old Unitarian Church.....	01 23.43	13 04.03	do	Do.
Marine Hospital, flagstaff.....	23 21.22	02 43.70	do	Do.
Massachusetts north base.....	03 06.59	12 24.87	do	Do.
McLean Asylum, north dome.....	22 37.26	04 54.68	do	Do.
Medford:				
Tall square chimney near Malden bridge.....	24 52.20	06 31.54	do	Do.
Unitarian church.....	25 13.97	06 56.23	do	Do.
Milldam:				
Regatta house flagstaff.....	21 04.89	05 19.01	do	Do.
Yellow house, chimney.....	20 56.22	05 51.67	do	Do.
Miller River, head of church.....	22 44.08	05 48.79	do	Do.
Milton:				
Church.....	15 12.35	04 50.38	do	Do.
Old church.....	15 12.35	04 50.38	do	Do.
Mills, tall church spire.....	16 26.49	04 07.96	do	Do.
Mount Auburn.....	22 10.94	08 40.37	do	Do.
Mount Daniel.....	01 41.54	48 10.30	do	Do.
Mugget.....	08 02.12	57 26.24	do	Do.
National dock building.....	22 02.92	02 33.56	do	Do.
Naval Hospital.....	23 22.58	02 55.94	do	Do.
Navy-Yard:				
Battery.....	22 23.97	03 06.32	do	Do.
Chimney.....	22 30.04	03 09.16	do	Do.
Nealys House.....	21 22.37	06 27.13	do	Do.
Neponset church.....	17 11.62	07 52.87	do	Do.
New England Glass Company, chimney.....	22 21.35	04 40.31	do	Do.
North Brighton, dark spire.....	21 13.69	08 12.35	do	Do.
Northeast corner of Connecticut.....	01 24.82	48 04.20	do	Do.
Northwest corner of Rhode Island.....	00 29.15	47 58.92	do	Do.
Observatory.....	25 53.23	37 37.19	G. S.	Bull. 122,
Octagonal building.....	21 37.37	04 19.02	C. & G. S.	Rept. '85.
One-story red building.....	22 07.93	04 17.38	do	Do.
Organ factory.....	21 44.45	04 58.17	do	Do.
Outer Brewster.....	20 29.40	52 41.16	do	Do.
Otter street.....	21 21.48	04 24.90	do	Do.
Peck's chimney.....	22 51.09	03 03.64	do	Do.
Pepperell.....	42 12.64	35 12.59	do	Do.
Petty Rock.....	16 16.05	06 49.62	do	Do.
Planing mill, chimney.....	22 16.17	07 17.17	do	Do.
Point Curve.....	21 14.02	02 56.28	do	Do.
Poplar Hill, stone monument.....	44 11.56	15 20.30	do	Do.
Powderhorn.....	24 04.68	01 52.01	do	Do.
Powderhorn, 2.....	24 04.56	01 52.05	do	Do.
Powers and Melville's elevator.....	22 59.03	04 40.01	do	Do.
Prentice coal wharf, post.....	21 08.76	03 11.58	do	Do.
Prospect:				
Somerville.....	22 54.62	05 37.88	do	Do.
Waltham.....	23 18.83	15 15.33	do	Do.
Quincy, stone church.....	15 04.25	00 12.98	do	Do.
Red Brush.....	01 49.55	22 23.46	do	Do.
Reservoir.....	20 47.50	34 05.96	G. S.	Bull. 122,
Riverside Press, chimney.....	21 46.03	06 57.05	C. & G. S.	Rept. '85.
Roxbury:				
Dr. Putnam's church.....	19 47.81	05 24.96	do	Do.
Laboratory, chimney.....	19 24.52	05 52.98	do	Do.
Tall spire in Jamaica Plains.....	18 36.44	06 59.36	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			71°-72°				
	°	'	"	°	'	"		
Roxbury—Continued.	42	19	42.11	71	04	51.72	C. & G. S.	Rept. '85.
New Unitarian church		19	55.40		03	55.14	do	Do.
Oil works, chimney		21	19.10		03	08.40	do	Do.
Sailors' Home, cupola		18	42.75		05	41.40	do	Do.
Sargent's Observatory		19	31.09		03	46.58	do	Do.
South Bay, tripod								
Somerville:								
Church near Malden bridge		23	07.43		04	36.63	do	Do.
Church on hill		23	12.18		05	52.37	do	Do.
Red church		23	11.98		05	52.46	do	Do.
South Boston:								
Dark spire, cross		20	31.87		03	24.44	do	Do.
Point		20	13.02		01	33.45	do	Do.
Reservoir		19	58.48		02	46.56	do	Do.
Sea wall		21	18.40		02	43.48	do	Do.
Squantum		18	13.89		00	41.57	do	Do.
Standard sugar refinery		20	44.00		03	15.58	do	Do.
Stone powder house		24	00.40		07	00.17	do	Do.
Suffolk cordage factory, ball		19	38.04		04	20.24	do	Do.
Sumner		15	21.05		09	32.22	do	Do.
Ten Hill farm, flag		23	50.88		05	15.26	do	Do.
Thompson Island:								
Flag		19	14.60		00	16.12	do	Do.
Pole near farm school		19	07.56		00	26.01	do	Do.
Town Hill		38	15.54		59	05.39	G. S.	Bull. 122.
Tudor, cupola		22	14.98		03	39.81	C. & G. S.	Rept. '85.
Tuft College		24	26.84		07	13.85	do	Do.
Turkey Hill		35	28.03		42	41.63	G. S.	Bull. 122.
Varnish factory, chimney		21	49.54		07	06.33	C. & G. S.	Rept. '85.
Wachusett:								
Chimney		29	21.28		53	15.13	G. S.	Bull. 122.
C. & G. S. station		29	20.78		53	13.98	do	Do.
Waite, 1		26	00.83		03	57.96	C. & G. S.	Rept. '85.
Waite, 2		26	20.43		01	13.14	do	Do.
Watertown Arsenal		21	42.72		09	45.97	do	Do.
Watatick:								
C. & G. S. station		41	48.55		53	34.87	G. S.	Bull. 122.
State line		42	40.93		53	55.73	C. & G. S.	Rept. '85.
Tree		41	48.47		53	34.40	G. S.	Bull. 122.
Waverly House		22	17.56		03	46.42	C. & G. S.	Rept. '85.
Wellington Hill		16	59.24		05	44.08	do	Do.
West Boston bridge, pole on draw		21	41.49		04	26.12	do	Do.
West Cambridge, tall spire with clock		24	55.63		09	15.82	do	Do.
Winnisimmet, church with clock		23	27.35		02	18.18	do	Do.
Winslow's factory, corner		23	02.22		03	53.96	do	Do.
Amherst	42	22	15.30	72	31	07.00	do	Do.
Agricultural College belfry		23	26.31		31	46.50	do	Do.
Agricultural College drill-hall tower.		23	17.06		31	43.56	do	Do.
Agricultural College flagstaff		23	21.69		31	42.64	do	Do.
City, Methodist church tower		24	50.34		30	32.79	do	Do.
College Hall		22	22.02		31	14.42	do	Do.
Congregational church spire		22	32.07		31	00.60	do	Do.
Episcopal church spire		22	29.76		31	09.06	do	Do.
Lawrence Observatory		22	17.06		31	10.05	do	Do.
Walker Hall tower		22	18.21		31	02.82	do	Do.
Williston Hall tower		22	17.76		31	06.59	do	Do.
Battlecock		23	02.70		46	25.40	do	Do.
Belchertown:								
Baptist church tower		16	40.81		24	04.66	do	Do.
First Congregational church spire.		16	42.68		24	05.98	do	Do.
High School tower		16	37.90		24	11.95	do	Do.
Methodist church tower		16	42.12		24	10.26	do	Do.
Boundary Rock		01	53.84		16	18.42	do	Do.
Brush		09	03.89		39	39.62	do	Do.
Chestnut Hill		24	34.30		39	40.10	do	Do.
Chicopee:								
French Catholic church spire		08	49.11		35	34.15	do	Do.
Catholic church spire		08	40.28		36	20.25	do	Do.
Skating rink spire		08	50.25		36	36.77	do	Do.
Chicopee Falls:								
Congregational spire		09	25.06		34	51.70	do	Do.
Catholic church spire		09	42.82		34	51.06	do	Do.
Methodist church spire		09	25.50		35	00.37	do	Do.
New Baptist church spire		09	26.08		34	54.10	do	Do.
Town Hall spire		08	54.65		36	25.94	do	Do.
Colonel Mountain		14	09.35		13	58.35	do	Do.
Connecticut line, signal (Borden)		01	55.98		20	46.14	do	Do.
Connecticut River Lumber Co., chimney.		17	29.65		37	14.30	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			72°-73°				
	°	'	"	°	'	"		
Conway Township, southeast corner.	42	27	30.25	72	39	28.34	C. & G. S.	Rept. '85.
Craft		12	46.51		38	20.46	do	Do.
Dickinson, flag in tree		25	31.50		30	26.60	do	Do.
Dolbar Hill		32	45.62		03	30.40	G. S.	Bull. 122.
East bench mark		12	53.96		36	10.22	C. & G. S.	Rept. '85.
Easthampton:								
First Congregational church spire.		16	20.74		40	17.24	do	Do.
Methodist church spire		16	15.79		40	22.28	do	Do.
Payson Congregational church spire.		16	12.02		40	22.78	do	Do.
Williston, Knight & Co., chimney.		16	00.90		40	11.40	do	Do.
Williston Mills, tower		16	27.69		39	33.42	do	Do.
Williston Seminary gymnasium, tower.		16	13.85		40	16.00	do	Do.
Town Hall, tower		16	16.66		40	21.85	do	Do.
East Longmeadow, Congregational spire.		03	51.49		30	45.62	do	Do.
East tidal bench mark		12	53.95		36	10.40	do	Do.
Facing Rock		13	08.84		27	35.00	do	Do.
Feeding Hills		03	52.20		40	53.75	do	Do.
Congregational spire		04	04.15		40	45.48	do	Do.
Methodist spire		03	58.94		40	44.54	do	Do.
Florence:								
Methodist church spire		20	07.10		40	25.20	do	Do.
Engine-house tower		20	04.50		40	19.40	do	Do.
Catholic church spire		19	56.78		40	07.03	do	Do.
Congregational church spire		19	54.16		40	30.00	do	Do.
Manufacturing Co.'s mill, tower		19	53.57		40	44.64	do	Do.
School-house tower		19	51.98		40	33.41	do	Do.
Granby, Congregational church spire.		15	22.87		31	04.12	do	Do.
Hadley:								
First Congregational church spire		20	30.88		35	20.81	do	Do.
Second Congregational church spire.		20	33.90		35	47.72	do	Do.
Hatchet		01	39.60		04	46.74	do	Do.
Hatfield:								
Congregational church spire		22	13.68		35	50.97	do	Do.
Smith Academy, tower		22	15.68		35	44.70	do	Do.
Hawes Hill		27	26.43		07	07.18	do	Do.
Haydensville:								
Catholic church spire		22	22.87		41	53.70	do	Do.
Congregational church spire		21	15.34		41	39.08	do	Do.
High Ridge Hill		26	55.14		43	06.66	do	Do.
Hilliard Knob		18	20.23		30	38.37	do	Do.
Hitchcock		05	07.39		15	35.43	do	Do.
Holland House, chimney		05	05.04		42	14.89	do	Do.
Holyoke:								
City Hall tower		12	24.32		30	28.10	do	Do.
Engine-house tower		12	46.50		37	31.98	do	Do.
First Congregational belfry		12	41.16		37	49.36	do	Do.
Windsor Hotel tower		12	23.07		36	22.72	do	Do.
St. Jerome's Catholic spire		12	34.10		36	31.76	do	Do.
Second Baptist tower		12	24.78		36	48.58	do	Do.
Second Congregational tower		12	18.36		36	39.50	do	Do.
Indian Orchard, church spire		09	32.02		30	07.04	do	Do.
Jenksville, church tower		09	31.91		29	06.70	do	Do.
Jenksville, church tower, 2		09	30.19		28	58.94	do	Do.
Ludlow, Methodist tower		11	29.10		27	09.72	do	Do.
Leverett, Congregational church spire.		27	07.80		30	06.90	do	Do.
Longmeadow, Congregational church spire.		03	00.83		34	56.24	do	Do.
McCarthy		04	13.05		30	17.18	do	Do.
Mount Esther		27	10.19		39	54.64	do	Do.
Mount Holyoke Hotel, flagstaff		18	02.10		35	17.70	do	Do.
Mount Lincoln		21	49.38		25	24.53	do	Do.
Mount Toby		29	16.32		32	16.28	do	Do.
Mount Tom		14	30.80		38	55.06	do	Do.
Mount Warner		22	48.40		34	22.20	do	Do.
New Braintree, Congregational church spire		19	01.16		07	35.90	do	Do.
Nonotuck Hotel, tower		16	47.86		37	15.20	do	Do.
North Amherst, Congregational church spire.		24	36.74		31	52.29	do	Do.
North Base		28	46.15		36	43.57	do	Do.
North Hadley, Congregational church spire.		23	19.70		34	52.10	do	Do.
Northampton:								
Lunatic Asylum tower		18	52.16		38	51.00	do	Do.
Catholic church tower		19	38.61		38	02.98	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			72°-73°				
	°	'	"	°	'	"		
Northampton—Continued.	42	19	16.38	72	37	42.57	C. & G. S.	Rept. '85.
Episcopal church tower		19	09.25		37	53.14	do	Do.
First Congregational church spire		19	10.72		37	59.58	do	Do.
Methodist church spire		19	27.53		38	22.38	do	Do.
Round Hill flagstaff		19	04.62		38	04.32	do	Do.
Second Congregational church spire.								
North Warner	22	56.00		34	17.90		do	Do.
Packard	27	40.64		21	11.09		do	Do.
Palmer, Universalist church spire	09	28.06		19	35.91		do	Do.
Peaked Mountain	02	50.94		20	26.20		do	Do.
Pelham, church spire	23	32.30		24	17.34		do	Do.
Rattle, flag in tree	01	59.08		24	28.67		do	Do.
Rattlesnake	01	59.58		24	28.60		do	Do.
Rock Rimmon	14	23.14		26	29.07		do	Do.
Secondary signal	02	23.04		54	07.82		do	Do.
Shingle Hill	23	23.30		41	59.50		do	Do.
Shutesbury:								
Congregational church spire	27	11.85		24	37.34		do	Do.
Baptist church spire	27	10.31		24	36.46		do	Do.
House, chimney	27	42.20		24	41.61		do	Do.
South Amherst, church spire	20	25.45		30	13.94		do	Do.
South Deerfield, Congregational church spire.	28	44.71		36	27.16		do	Do.
South Hadley, Congregational church spire.	15	31.59		34	31.26		do	Do.
South Hadley Falls:								
Catholic church spire	13	13.03		36	05.58		do	Do.
Congregational church spire	12	58.25		35	56.56		do	Do.
Methodist church spire	13	00.92		35	56.42		do	Do.
Female Seminary Observatory	15	21.78		34	40.88		do	Do.
Springfield:								
Arsenal, clock tower	06	26.48		34	54.70		do	Do.
Court-house tower	06	01.48		35	21.02		do	Do.
First Baptist church spire	06	10.88		35	04.19		do	Do.
Florence Street Methodist church spire.	06	01.11		34	03.72		do	Do.
Hope Congregational church tower.	06	38.69		33	55.63		do	Do.
North Congregational church spire.	06	21.77		35	13.45		do	Do.
St. Joseph's Catholic church spire.	06	06.63		35	10.64		do	Do.
South Congregational church spire.	06	08.04		35	00.10		do	Do.
St. Michael's church spire	06	15.20		35	05.10		do	Do.
State Street Methodist church spire.	06	19.18		34	53.36		do	Do.
Water-shops tower	05	51.94		33	50.44		do	Do.
Sugarloaf Hotel:								
South chimney	28	13.00		35	32.98		do	Do.
North chimney	28	13.30		35	33.08		do	Do.
Sunderland:								
Schoolhouse tower	28	02.32		34	44.74		do	Do.
Congregational church tower	27	57.91		34	49.70		do	Do.
Three Rivers, French Catholic church spire.	11	00.72		21	21.30		do	Do.
Tuft Hill	19	01.54		05	04.56		do	Do.
Two Tree	39	10.99		08	40.19		G. S.	Bull. 122.
Ward Hill	34	12.13		10	24.85		do	Do.
Warwick (Borden)	43	21.57		19	14.26		C. & G. S.	Rept. '85.
West bench mark	12	44.22		36	14.10		do	Do.
West Hampton, Congregational church spire.	18	16.57		46	32.39		do	Do.
West Springfield, First Congregational church spire.	06	52.18		37	31.94		do	Do.
Whately Congregational church spire	26	17.10		38	07.40		do	Do.
White, flag in tree	12	02.27		29	47.53		do	Do.
Wigwam	06	26.00		24	45.10		do	Do.
Wilbraham:								
Congregational church spire	07	16.48		25	54.87		do	Do.
Rich Hall, tower	07	27.68		25	55.10		do	Do.
	42°-43°			73°-74°				
	°	'	"	°	'	"		
Alander Mountain	42	05	15.06	73	30	18.72	do	Do.
Bald Peak		06	07.30		25	59.11	do	Do.
Brace Mountain		02	39.91		29	34.88	do	Do.
Corner stone, southwest corner of State.		02	58.38		29	15.96	do	Do.
Dome Peak		06	07.30		25	59.11	do	Do.
French Hill		25	38.46		02	16.44	do	Do.
Greylock		38	14.09		09	59.13	do	Do.
Iron Bolt		02	58.67		29	42.62	do	Do.
Perry Peak		25	15.65		22	48.78	do	Bull. 122.

MASSACHUSETTS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43°	73°-74°		
	° ' "	° ' "		
Ryant Bush.....	42 03 04.05	73 28 56.63	C. & G. S.	Bull. 122.
Washington spire.....	21 57.78	08 39.78	do	Do.
	41°-42°	69°-70°		
	° ' "	° ' "		
Basin.....	41 39 48.50	69 56 41.66	do	Rept. '85.
Camp.....	43 59.58	59 33.25	do	Do.
Chatham.....	41 50.70	58 48.38	do	Do.
Congregational church spire.....	40 58.54	57 41.72	do	Do.
Flagstaff.....	40 43.77	57 23.51	do	Do.
North light-house.....	40 18.28	57 01.27	do	Do.
South light-house.....	40 17.30	57 01.50	do	Do.
Spire.....	41 02.79	57 39.96	do	Do.
Cove.....	36 56.18	58 35.17	do	Do.
Crows Lookout.....	43 06.96	58 25.46	do	Do.
Cumming flagstaff.....	47 12.17	57 04.36	do	Do.
Eastham, Congregational church spire.....	50 28.28	58 54.33	do	Do.
Eldridge.....	44 34.88	58 39.69	do	Do.
Harding Beach.....	39 31.55	59 03.16	do	Do.
Lombard Head.....	55 51.66	58 51.02	do	Do.
Marsh.....	43 51.92	55 39.55	do	Do.
Mayo.....	46 00.17	57 10.44	do	Do.
Monomoy.....	35 37.60	59 03.36	do	Do.
Light-house.....	33 33.78	59 39.02	do	Do.
Morris Island.....	39 29.48	57 34.14	do	Do.
Mosquito.....	39 26.91	57 32.60	do	Do.
Namequoit.....	45 26.74	57 42.48	do	Do.
Nauset:				
Beach.....	44 05.66	55 34.32	do	Do.
Center light-house.....	51 38.63	57 05.42	do	Do.
Harbor.....	47 22.72	56 46.80	do	Do.
Old Harbor.....	42 19.94	59 01.11	do	Do.
Orleans, Orthodox church spire.....	47 04.86	58 30.20	do	Do.
Pine.....	40 08.56	59 35.48	do	Do.
Pleasant Bay.....	44 34.89	58 39.64	do	Do.
Pochet.....	46 39.98	56 26.09	do	Do.
Sampson.....	45 21.74	57 00.43	do	Do.
Sankaty Head.....	16 59.91	57 53.41	do	Do.
Sankaty Head light-house.....	17 01.21	57 56.52	do	Do.
Shells.....	57 52.80	57 41.45	do	Do.
Sipson Island.....	44 09.28	57 52.03	do	Do.
South Wellfleet:				
Congregational church belfry.....	54 32.07	59 07.10	do	Do.
Methodist meetinghouse.....	54 24.54	59 07.72	do	Do.
Squam Head.....	19 33.48	59 56.05	do	Do.
Stage Harbor light-house.....	39 31.55	59 03.16	do	Do.
Strong.....	43 12.48	57 29.61	do	Do.
	41°-42°	70°-71°		
	° ' "	° ' "		
Aldin.....	41 49 48.33	70 57 02.79	do	Do.
Angelica Point.....	38 28.97	45 55.35	do	Do.
Atwood.....	45 11.39	04 24.31	do	Do.
Back River Harbor.....	43 18.58	36 50.49	do	Do.
Barnstable.....	41 48.82	18 25.58	do	Do.
West spire.....	41 54.89	23 03.28	do	Do.
Court-house.....	42 06.02	18 17.64	do	Do.
Light-house.....	43 21.16	16 53.34	do	Do.
Unitarian spire.....	42 02.46	17 57.67	do	Do.
Bass Hole.....	42 49.98	14 15.54	do	Do.
Bass River.....	38 38.44	12 12.13	do	Do.
Light-house.....	39 06.44	10 10.84	do	Do.
Billingsgate light-house.....	52 18.22	04 09.87	do	Do.
Bird Island light-house.....	40 09.65	43 01.14	do	Do.
Bishop and Clerks.....	34 27.44	15 01.96	do	Do.
Light-house.....	34 27.52	15 02.04	do	Do.
Blackfish Creek.....	54 28.86	01 04.80	do	Do.
Bluff (Nantucket).....	17 31.40	06 26.77	do	Do.
Bourne Hill.....	44 00.82	29 11.63	do	Do.
Bowman Hill observatory.....	32 38.10	36 04.32	do	Do.
Bowman Point.....	32 36.46	36 05.84	do	Do.
Brant Point light-house.....	17 23.20	05 34.61	do	Do.
Brewster.....	46 12.76	04 46.46	do	Do.
Unitarian church spire.....	45 43.24	04 57.32	do	Do.
Cambria.....	59 14.88	00 45.13	do	Do.
Cape Poge.....	25 11.50	27 03.75	do	Do.
Light-house.....	25 16.03	27 05.70	do	Do.
Centerville church.....	38 44.94	20 49.27	do	Do.
Charles Neck.....	40 21.61	44 45.04	do	Do.
Clark Cove.....	15 20.47	10 43.16	do	Do.
Clark Point.....	35 34.15	54 03.69	do	Do.
Light-house.....	35 34.28	54 03.91	do	Do.
Coatue Point.....	19 06.62	02 57.07	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			70°-71°				
	°	'	"	°	'	"		
Coatue Point, 2	41	18	05.39	70	04	39.87	C. & G. S.	Rept. '85.
Collier Ledge		35	48.36		21	06.69	do	Do.
Cotuit Neck		35	31.16		26	44.25	do	Do.
Cromeset Neck		43	41.74		43	20.57	do	Do.
Cuttyhunk		25	14.89		56	02.65	do	Do.
Light-house		24	52.36		57	00.18	do	Do.
Davis Hill		31	24.30		39	39.24	do	Do.
Davis Neck		32	54.42		33	48.63	do	Do.
Desert Hill		29	28.73		44	21.35	do	Do.
Dumpling Rock (Round Hill) light-house.		32	17.88		55	19.09	do	Do.
Duxbury Pier light-house		59	14.94		38	56.57	do	Do.
East Chop		28	04.80		33	50.91	do	Do.
Telegraph		28	04.72		33	49.00	do	Do.
Light-house		28	13.44		34	04.96	do	Do.
East Chop, 2		28	04.63		33	50.90	do	Do.
East Scargo (Borden)		44	00.87		10	16.39	do	Do.
East Plymouth		52	58.09		32	01.74	do	Do.
Eastham		49	26.09		00	14.92	do	Do.
Edgartown		23	51.77		32	55.96	do	Do.
Light-house		23	27.29		30	12.76	do	Do.
Spire		23	18.64		30	55.88	do	Do.
Eel River, steeple		56	15.18		37	49.12	do	Do.
Fair Haven, black spire		38	09.81		54	18.85	do	Do.
Falmouth		35	53.11		37	05.48	do	Do.
Spire		33	14.95		37	12.52	do	Do.
Fish-house, north gable		38	19.40		10	38.15	do	Do.
Folger, astronomic station		17	16.94		06	16.56	do	Do.
Forked Pond		14	15.94		01	03.65	do	Do.
Further Creek		16	39.72		14	06.85	do	Do.
Gay Head		20	50.30		50	13.96	do	Do.
Light-house		20	54.59		50	07.58	do	Do.
German Hill		41	27.96		12	35.98	do	Do.
Gibb Pond		16	53.65		01	31.46	do	Do.
Great Hill		42	33.28		43	20.44	do	Do.
Great Point (Nantucket) light-house		23	24.34		02	46.06	do	Do.
Great Rock, spindle		37	03.52		17	10.38	do	Do.
Griffin Island		56	14.37		04	06.05	do	Do.
Hamblin Hill		41	49.93		24	13.64	do	Do.
Hamblin Mound		56	14.18		02	47.46	do	Do.
Harwich belfry		41	12.39		04	35.97	do	Do.
Harwich Port		39	51.30		04	06.57	do	Do.
Herring Pond		20	47.35		31	34.16	do	Do.
Highland House, north tower		27	50.26		33	36.17	do	Do.
Hog Island Harbor		36	15.84		38	57.00	do	Do.
Holmes		55	26.56		32	39.02	do	Do.
Holmes Hole (or West Chop) light-house.		28	51.06		36	00.96	do	Do.
Holmes Hole		28	57.66		36	10.78	do	Do.
Holmes Hole, spire		27	15.15		36	20.18	do	Do.
Hopkins		46	02.05		02	51.54	do	Do.
Hyannis		37	53.34		18	26.67	do	Do.
West spire		39	05.77		17	15.21	do	Do.
Light-house		38	10.79		17	20.20	do	Do.
Universalist spire		39	14.38		16	56.08	do	Do.
Indian		25	46.74		40	40.70	do	Do.
Brook		51	30.36		00	23.41	do	Do.
Hill		52	58.13		32	01.75	do	Do.
Neck		43	33.27		41	27.05	do	Do.
Kingston		58	53.29		41	54.63	do	Do.
Kingston spire		59	36.08		43	52.77	do	Do.
Kotayma House, north tower		21	30.10		30	19.67	do	Do.
Long Neck		44	20.21		38	45.42	do	Do.
Mannerson		41	31.14		12	16.86	do	Do.
Manomet		55	38.70		35	28.13	do	Do.
Marston Mill		38	49.68		24	56.98	do	Do.
Mattapoisett, gray spire		39	43.93		49	12.28	do	Do.
Mattapoisett Neck		37	46.57		48	11.30	do	Do.
Mayo Beach light-house		55	49.82		02	05.66	do	Do.
Menauhant Hotel, west chimney		33	01.00		33	09.76	do	Do.
Menauhant Landing, flagstaff		32	59.68		33	08.92	do	Do.
Mendal (Borden)		42	03.03		53	00.02	do	Do.
Mill Hill		46	34.14		00	06.97	do	Do.
Mishaum Point		30	56.11		57	16.44	do	Do.
Monaunt Hill		33	05.51		32	32.48	do	Do.
Monks Hill		57	39.11		43	23.40	do	Do.
Monument church		44	32.45		35	49.73	do	Do.
Muskeget Island		20	14.11		17	58.47	do	Do.
Nantucket:								
Baptist church		16	52.66		06	07.00	do	Do.
Great Point light-house		23	24.34		02	46.06	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			70°-71°				
	°	'	"	°	'	"		
Nantucket—Continued.								
North towered church	41	17	09.94	70	06	08.22	C. & G. S.	Rept. '85.
Cliff Range beacon (rear)		17	35.55		06	25.10	do	Do.
Cliff		17	35.81		06	53.79	do	Do.
South towered Unitarian church		16	56.72		05	58.09	do	Do.
Range beacon		16	23.92		04	42.86	do	Do.
Nashaquitsa Cliff		20	00.34		44	27.30	do	Do.
Nashawena		25	30.97		52	06.61	do	Do.
Naushon		29	25.03		44	33.38	do	Do.
Southwest		27	01.82		47	19.97	do	Do.
Northeast		30	35.72		42	48.91	do	Do.
Ned Point light-house		39	03.34		47	46.11	do	Do.
New Bedford:								
Court-house		38	03.72		55	52.96	do	Do.
Baptist church		38	12.37		55	36.98	do	Do.
Beacon		36	33.62		53	28.73	do	Do.
Fort		37	27.06		54	10.37	do	Do.
New Falmouth		33	42.42		37	52.42	do	Do.
Nobska Point light-house		30	57.24		39	20.20	do	Do.
No Man's Land		15	11.70		48	49.20	do	Do.
North Dennis		44	42.24		12	29.82	do	Do.
Gray spire		44	14.85		11	32.53	do	Do.
White spire		44	13.77		11	35.41	do	Do.
North Dennis, 2		43	29.20		12	04.70	do	Do.
North Falmouth, spire		38	33.32		37	07.29	do	Do.
North Plymouth Rope Works		58	47.50		41	20.16	do	Do.
North Pond		17	38.41		10	32.15	do	Do.
North Wellfleet:								
Methodist belfry		56	19.66		01	48.95	do	Do.
Congregational belfry		56	09.64		01	16.48	do	Do.
Orleans		47	32.47		00	51.46	do	Do.
Orleans, 2		47	32.59		00	51.63	do	Do.
Osterville		37	52.16		22	57.14	do	Do.
Spire		37	42.08		23	09.29	do	Do.
Osterville Point		37	02.13		22	10.70	do	Do.
Padanaram		35	39.27		56	35.73	do	Do.
Gray spire		35	20.12		56	28.07	do	Do.
Palmer Island light-house		37	37.27		54	34.72	do	Do.
Pamanset River		31	41.30		59	30.99	do	Do.
Pasque		26	57.82		50	04.43	do	Do.
Peaked Cliff		48	31.38		32	25.06	do	Do.
Penikese		26	58.17		55	26.91	do	Do.
Pigeon Hill		50	58.24		59	44.57	do	Do.
Pine Hill		42	31.13		33	58.61	do	Do.
Plymouth		57	24.78		40	07.93	do	Do.
National monument		57	36.69		40	34.87	do	Do.
Pier head		58	46.50		39	13.38	do	Do.
Court-house		57	26.37		40	02.23	do	Do.
Cliff		49	40.62		32	37.24	do	Do.
Pocasset, spire		41	41.55		36	18.28	do	Do.
Point Gammon		37	04.96		15	39.32	do	Do.
Point Gammon, 2		37	04.96		15	39.32	do	Do.
Point Gammon light-house		36	35.00		16	00.19	do	Do.
Prospect Chilmark		21	56.84		44	51.05	do	Do.
Prospect House, cupola flagstaff		26	41.34		34	45.39	do	Do.
Rock Point		46	12.95		04	46.02	do	Do.
Round Hill		32	24.79		55	50.59	do	Do.
Round Hill (Dumpling Rock), light-house.		32	17.88		55	19.09	do	Do.
Sampson (Marthas Vineyard)		22	41.51		29	02.66	do	Do.
Sandwich, Orthodox church		45	28.35		30	00.45	do	Do.
Scargo		44	22.48		10	49.82	do	Do.
Schaum		45	25.10		30	49.98	do	Do.
Scoticut Neck		35	02.65		51	20.39	do	Do.
Scorton Hill		43	17.26		23	41.43	do	Do.
Scorton Neck		44	19.13		24	41.19	do	Do.
Scraggy Neck		39	59.28		39	15.57	do	Do.
Sears		44	38.30		07	57.09	do	Do.
Seaview House, north tower		27	28.54		33	23.06	do	Do.
Shawankemo		17	01.80		03	04.82	do	Do.
Shootflying		41	07.33		20	49.74	do	Do.
Sippican church		42	09.92		45	47.88	do	Do.
Sippican Neck		40	35.93		42	58.05	do	Do.
South Dennis		39	06.59		08	12.40	do	Do.
North spire		40	34.25		09	24.49	do	Do.
South spire		40	21.64		09	23.64	do	Do.
South Pocasset spire		40	36.28		36	22.83	do	Do.
Spring Hill Academy		44	58.86		27	36.58	do	Do.
Succonneset		33	31.43		28	36.29	do	Do.
Sursuit Creek		45	32.41		08	37.40	do	Do.
Swift Hill		34	02.46		38	30.70	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			70°-71°				
	°	'	"	°	'	"		
Tarpaulin Cove light-house	41	28	07.90	70	45	28.74	C. & G. S.	Rept. '85.
Tempes Knob		42	58.46		39	48.84	do	Do.
Truro, Congregational church spire ..		59	54.06		03	18.44	do	Do.
Tuckamuck telegraph		18	14.51		15	08.47	do	Do.
Union chapel		27	16.82		33	31.05	do	Do.
Wareham Baptist church		45	27.19		43	03.63	do	Do.
Watcha		20	52.19		36	38.35	do	Do.
Weeweeder Pond		14	35.28		05	37.92	do	Do.
Wenauet Neck		40	58.14		39	41.00	do	Do.
West Chatham		40	09.42		01	42.19	do	Do.
West Chop		28	54.29		36	18.04	do	Do.
West Chop (Holmes Hole) light-house ..		28	51.06		36	00.96	do	Do.
West Chop, 2		28	52.61		35	58.26	do	Do.
West Island		34	56.62		49	20.79	do	Do.
West Island, 2		35	25.09		49	04.85	do	Do.
West Yarmouth, spire		38	59.08		13	46.73	do	Do.
Wild Harbor		38	22.19		39	09.05	do	Do.
Windmill Range		16	40.22		06	49.57	do	Do.
Wing Neck light-house		40	49.38		39	41.75	do	Do.
Wolasha Hill		20	29.02		48	38.50	do	Do.
Woods Hole		31	38.80		39	41.58	do	Do.
Episcopal church		31	19.86		39	48.10	do	Do.
Yarmouth Port, spire		42	24.82		14	37.13	do	Do.
	41°-42°			71°-72°				
Alex	41	54	07.08	71	03	34.97	do	Do.
Almy		30	42.29		01	49.85	do	Do.
Attleboro		56	54.14		17	22.60	do	Do.
Assonet		47	25.35		05	56.88	do	Do.
Spire		47	45.95		04	08.00	do	Do.
Flat-topped church, west gable chimney.		47	30.26		04	15.24	do	Do.
Bare top		48	52.85		06	00.44	do	Do.
Beacon		42	16.82		10	29.71	do	Do.
Beveled barn		50	12.73		07	09.14	do	Do.
Birch		52	08.52		05	04.66	do	Do.
Blackbeard		40	28.88		10	58.83	do	Do.
Bluff (Taunton River)		45	54.52		07	49.70	do	Do.
Bradford		54	17.32		04	38.04	do	Do.
Briggs (Taunton River)		54	56.20		03	49.46	do	Do.
Brown Hill (Taunton River)		47	25.29		06	27.65	do	Do.
Bryant Hill		49	39.79		04	43.71	do	Do.
Burns		44	26.70		08	52.72	do	Do.
Burt		51	28.72		05	49.61	do	Do.
Canonicus		53	10.26		02	47.30	do	Do.
Calvary		43	40.82		08	05.04	do	Do.
Carpenter		51	36.08		05	33.64	do	Do.
Chase		40	23.92		11	16.46	do	Do.
City		41	43.77		10	19.09	do	Do.
Clark		51	52.70		05	13.14	do	Do.
Copecut		43	17.24		03	36.64	do	Do.
Cord		53	56.12		02	36.60	do	Do.
Cupola		52	31.55		05	48.05	do	Do.
Dartmouth		34	11.59		01	47.54	do	Do.
Dean		54	37.32		04	15.35	do	Do.
Depot		46	31.09		07	15.07	do	Do.
Dodge's stable, turret		40	56.33		10	40.24	do	Do.
Durfees, cupola		42	36.36		09	04.82	do	Do.
Eddy		54	24.83		03	58.18	do	Do.
Eldridge		31	46.11		05	08.27	do	Do.
Elisha		53	58.58		02	23.21	do	Do.
Elm		53	51.72		02	17.50	do	Do.
Fall River		42	39.25		08	45.54	do	Do.
Derrick		42	19.32		09	56.72	do	Do.
Tower		42	00.87		09	25.42	do	Do.
Spire		42	06.87		09	15.00	do	Do.
Fall River, 2		42	39.74		08	45.38	do	Do.
Ferry wharf, chimney		42	34.36		10	46.90	do	Do.
Frederick		53	41.36		04	27.12	do	Do.
Florence		50	45.03		06	58.03	do	Do.
French		53	35.60		05	34.67	do	Do.
Gardner Neck		42	33.74		12	24.81	do	Do.
George		53	17.58		02	48.11	do	Do.
Globe village, chimney		41	17.27		10	23.84	do	Do.
Gooseberry Neck		29	20.08		02	19.61	do	Do.
Grave		54	04.71		02	38.62	do	Do.
Graveyard		49	34.48		07	28.94	do	Do.
Great Rock		51	32.36		17	15.47	do	Do.
Great Meadow		52	45.14		13	02.29	do	Do.
Hall		54	22.37		04	16.29	do	Do.
Hampden		53	20.15		02	23.86	do	Do.

MASSACHUSETTS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			71°-72°				
	°	'	"	°	'	"		
Hatch (Taunton River)	41	53	01.44	71	05	13.98	C. & G. S.	Rept. '85.
Henry		54	23.12		03	12.80	do	Do.
Herbert		51	45.41		05	46.99	do	Do.
Herring River, spire		40	13.01		07	02.58	do	Do.
High		50	57.52		06	29.89	do	Do.
Hoppin Hill		57	52.71		20	52.27	do	Do.
Hunt		52	38.99		05	30.23	do	Do.
Jesse		53	11.99		02	19.21	do	Do.
Johnson		53	20.81		04	43.52	do	Do.
Joe Sandford		35	37.56		07	55.53	do	Do.
Kimball		53	48.39		02	27.11	do	Do.
King		54	22.66		03	49.49	do	Do.
King Rock		45	22.82		16	17.27	do	Do.
Mack		47	30.99		07	02.32	do	Do.
Maplewood		53	27.74		02	12.91	do	Do.
Marsh (Taunton River)		47	38.18		07	33.80	do	Do.
Martin		54	23.42		03	28.48	do	Do.
Mason		54	29.24		04	11.14	do	Do.
Massachusetts south base		54	49.92		18	16.11	do	Do.
Mattapoisett		42	40.47		12	51.76	do	Do.
Meadow		51	11.22		06	11.96	do	Do.
New		49	33.06		06	58.42	do	Do.
Nichols		48	25.97		06	59.36	do	Do.
Nootas		32	13.02		07	25.83	do	Do.
North Dighton		51	14.52		06	39.39	do	Do.
Norton, dark-red spire		58	10.49		10	55.37	do	Do.
Oak Hill		54	51.24		16	43.23	do	Do.
Padelford		54	08.02		03	12.26	do	Do.
Pine (Taunton River)		54	12.54		02	58.18	do	Do.
Quicksand		30	01.73		07	12.18	do	Do.
Quicksand, 2		29	56.40		07	09.16	do	Do.
Richmond Hill		48	27.29		07	43.35	do	Do.
Ridge		45	33.46		07	10.98	do	Do.
River		51	36.08		06	17.02	do	Do.
Roach		54	08.44		02	27.97	do	Do.
Rockheap		53	44.16		02	12.70	do	Do.
Sassacus		53	19.88		02	35.87	do	Do.
Schoolhouse Hill		50	01.41		06	17.56	do	Do.
Slade		43	41.20		10	09.12	do	Do.
Somerset		44	07.60		10	06.49	do	Do.
Meetinghouse		44	11.54		10	06.89	do	Do.
Spire		46	17.88		07	38.87	do	Do.
Somerset, 2		43	44.05		10	08.16	do	Do.
Squawbetty		53	20.27		02	05.70	do	Do.
White spire		52	57.37		01	39.97	do	Do.
Nail factory		53	12.16		01	54.03	do	Do.
Steep Brook		44	56.97		07	23.16	do	Do.
Steep Brook, church		44	30.40		07	46.13	do	Do.
Stonewall		53	34.08		02	04.19	do	Do.
Swanzy belfry		45	03.22		13	30.90	do	Do.
Sycamore		53	37.91		02	20.91	do	Do.
Taunton:								
Unitarian Church		54	04.57		05	19.92	do	Do.
Iron works, chimney		52	54.11		05	38.55	do	Do.
Telegraph		50	59.36		06	50.33	do	Do.
Terry		46	31.46		06	43.07	do	Do.
Thrasher		52	22.47		05	16.73	do	Do.
Verification:								
South base		50	13.04		21	28.68	do	Do.
North base		54	25.94		21	20.68	do	Do.
Walker		54	23.22		02	57.83	do	Do.
Washburn		53	25.41		01	56.49	do	Do.
Water tower		59	46.52		19	21.66	do	Do.
Waterworks		54	11.20		03	50.62	do	Do.
Weetamoe		53	08.94		02	30.19	do	Do.
Wilbur		54	40.30		05	11.67	do	Do.
Williams		52	43.06		05	52.70	do	Do.
Whitmore		52	12.51		05	31.91	do	Do.
Wood		45	03.10		08	27.35	do	Do.
Woods		54	19.08		02	44.92	do	Do.

RHODE ISLAND.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			71°-72°				
	°	'	"	°	'	"		
Achilles	41	19	15.35	71	48	47.54	C. & G. S.	Rept. '85.
Ajax		20	35.86		41	17.40	do	Do.
Aldrich		50	23.92		40	11.00	do	Bull. 122.
Anderson, barn cupola		33	41.31		17	23.46	do	Rept. '85.
Anthony		38	46.35		13	18.64	do	Do.
Mill		41	47.30		32	47.82	do	Bull. 122.
Apponaug, spire		41	55.84		27	30.08	do	Rept. '85.
Arnold		45	14.48		23	41.75	do	Do.
Austin		24	25.28		28	44.90	do	Do.
Babcock		42	44.36		18	24.80	do	Do.
Balch, house, north chimney		29	00.51		16	20.91	do	Do.
Barber Height		31	44.87		25	28.10	do	Do.
Barker		38	23.01		12	06.65	do	Do.
Barn cupola		32	08.72		22	36.98	do	Do.
Barn, white cupola		42	22.66		16	55.43	do	Do.
Barn, west gable		28	35.10		23	28.36	do	Do.
Batty		32	13.24		22	36.23	do	Do.
Farm		45	34.90		24	35.80	do	Do.
Beaconpole		59	42.47		27	01.26	do	Do.
Beaconpole (Borden)		00	03.26		26	43.16	do	Do.
Beavertail, light-house		26	56.86		23	59.42	do	Do.
Do		26	57.89		23	59.57	do	Do.
Bentley		21	51.91		45	33.28	do	Do.
Big Hill		23	26.36		46	08.49	do	Do.
Block Island		10	32.08		35	30.64	do	Do.
Derrick		09	10.01		33	08.80	do	Do.
North light-house (1874)		13	39.66		34	34.74	do	Do.
North light-house (1838)		13	29.15		34	33.05	do	Do.
Southeast light-house (1875)		09	10.12		33	08.39	do	Do.
Border Hill, topographical pole		23	26.74		38	29.70	do	Do.
Boston Neck		28	19.08		26	05.43	do	Do.
Bristol:								
Court-house		40	12.66		16	25.67	do	Do.
Methodist church		40	15.39		16	31.88	do	Do.
Broad Hill		24	39.95		33	42.82	do	Do.
Brown (E.), house chimney		19	54.22		45	25.62	do	Do.
Brown (E.), house cupola		45	04.44		23	24.20	do	Do.
Browning, house chimney		32	00.82		25	49.54	do	Do.
Browning (W.T.), house, center chimney.		23	12.44		34	36.28	do	Do.
Bullock Neck (Borden)		44	42.27		21	35.11	do	Do.
Bullock Neck		44	42.90		21	27.69	do	Do.
Bullock Neck, 2		44	43.00		21	35.16	do	Do.
Bunker Hill		23	10.16		39	16.35	do	Do.
Bushy Hill		12	43.99		33	40.56	do	Do.
Buttonwood House, cupola		41	19.12		25	58.28	do	Do.
Butts		36	55.84		15	06.56	do	Do.
Butts, 2		36	55.74		15	07.48	do	Do.
Calf Pasture Point		37	40.62		24	18.99	do	Do.
Castle Hill		27	53.02		21	28.80	do	Do.
Castle Island Beacon (1843)		39	13.97		17	12.20	do	Do.
Champlin		29	16.00		46	47.77	do	Do.
Do		29	16.04		46	47.91	G. S.	Bull. 122.
Church Point		30	00.12		12	23.96	C. & G. S.	Rept. '85.
Church Point, 2		30	09.92		12	21.01	do	Do.
Coal Mines, middle chimney		37	09.94		16	26.83	do	Do.
College Hill		50	18.85		24	00.63	do	Do.
Commons		21	15.21		43	54.70	do	Do.
Conanicut, north		34	24.86		22	19.87	do	Do.
Conimicut		43	01.67		21	29.44	do	Do.
Cormorant Hill		23	37.22		49	03.45	do	Do.
Cornell		37	18.96		09	16.52	do	Do.
Cranberry Hill		20	53.23		47	22.77	do	Do.
Cranberry Hill, 2		20	53.40		47	22.80	do	Do.
Davis (O.), house, east gable chimney.		20	56.91		44	09.26	do	Do.
Dawley		32	12.06		39	02.68	do	Bull. 122.
Diamond Hill, tree		25	46.62		46	28.73	do	Rept. '85.
Dumplin		28	45.68		22	07.86	do	Do.
Dumplin, 2		28	45.69		22	07.86	do	Do.
Dunn House, white chimney		21	06.38		46	07.44	do	Do.
Dutch Island:								
Flagstaff (1868)		30	19.30		24	04.75	do	Do.
Light-house (1868)		29	48.28		24	17.18	do	Do.
Dyer Island		34	57.25		17	55.49	do	Do.
East Rock		27	04.65		11	38.34	do	Do.
Fairground, tower		31	16.61		16	27.84	do	Do.
Fishhouse, chimney		34	41.97		26	51.84	do	Do.
Fogland Point House		33	42.90		13	11.65	do	Do.
Fort Adams:								
Flagstaff (1869)		28	45.88		20	20.25	do	Do.
Flagstaff (1843)		28	47.51		20	14.24	do	Do.

RHODE ISLAND—Continued.

Name.	Latitude.		Longitude.		Authority.	Reference.
	41°-42°		71°-72°			
	°	'	°	'		
Fort Hill	41	20 01.27	71	49 15.13	C. & G. S.	Rept. '85.
Fort Independence		47 34.44		23 33.38	do	Do.
Fort Independence, 2		47 34.41		23 33.49	do	Do.
Four Corners, belfry		34 31.52		11 22.41	do	Do.
Fox Island		33 16.24		25 04.48	do	Do.
House chimney		33 15.00		25 06.59	do	Do.
Fox Point, rolling-mill chimney		48 59.70		23 55.82	do	Do.
Franklin		35 41.35		33 56.30	do	Bull. 122.
Gibbs		29 36.69		16 29.18	do	Rept. '85.
Gibbs, 2		29 39.54		16 28.38	do	Do.
Goat Island, light-house (1843)		29 36.09		19 39.10	do	Do.
Gould Island		32 04.30		20 42.02	do	Do.
Barn cupola		32 02.03		20 41.06	do	Do.
Governors Island		21 19.42		39 12.29	do	Do.
Green, barn cupola		33 42.34		26 31.25	do	Do.
Green Hill		22 24.70		35 51.59	do	Do.
Green Point		41 03.60		24 43.18	do	Do.
Griswold, barn, south cupola		32 58.69		14 20.83	do	Do.
Halfway Rock		33 49.82		19 58.34	do	Do.
Hall		43 12.06		17 05.59	do	Do.
Hall (Ben), house, west chimney		35 08.27		16 41.43	do	Do.
Hamilton Mills, cupola		32 57.49		26 17.05	do	Do.
Harris, barn, east cupola		22 19.74		40 22.64	do	Do.
Hazard (A. P.)		28 23.25		19 17.59	do	Do.
House, center chimney		24 34.68		33 04.20	do	Do.
Castle		24 55.10		27 28.37	do	Do.
Hector		19 31.66		47 20.57	do	Do.
High Hill		32 51.03		12 59.46	do	Do.
High Rocks		37 47.56		26 08.78	do	Do.
Hiscox		21 29.18		42 14.56	do	Do.
Hog Island		38 40.38		16 50.58	do	Do.
Hog Island, 2		38 40.48		16 50.79	do	Do.
Hog Island, 3		38 40.48		16 50.82	do	Do.
Hope Island		36 10.30		21 59.62	do	Do.
Barn		36 09.97		22 00.42	do	Do.
Howland, barn cupola		32 04.17		11 46.08	do	Do.
Hull		32 14.56		22 36.23	do	Do.
James		32 41.81		39 52.97	do	Do.
Joshua Champlin		22 16.39		39 55.33	do	Do.
Kenyon		23 25.33		37 01.43	do	Do.
Kenyon (H. G.), house, center chimney		22 56.41		37 06.67	do	Do.
Kettle Point		47 46.34		22 41.04	do	Do.
Kingston, church spire		28 48.90		31 33.54	do	Do.
Kinnicut		47 47.84		21 57.48	do	Do.
Knapp Point, house chimney		18 22.53		53 07.63	do	Do.
Lawton, house, flagstaff		37 33.40		12 48.97	do	Do.
Liberty Pole		21 41.54		37 21.90	do	Do.
Little Compton		31 12.38		11 00.71	do	Do.
Little Compton, 2 (1870)		31 12.44		11 01.69	do	Do.
Church spire		30 33.63		10 18.35	do	Do.
McSparrow		29 46.95		27 24.74	do	Do.
McSparrow, 2		29 47.79		27 24.35	do	Do.
Meetinghouse Hill		26 45.32		28 33.93	do	Do.
Meetinghouse Hill, 2		26 43.17		28 33.55	do	Do.
Miantonomy		30 37.05		18 37.43	do	Do.
Mound		38 14.04		13 11.91	do	Do.
Mount Hope (Borden)		40 27.55		14 26.15	do	Do.
Mount Hope		40 26.13		14 26.21	do	Do.
Mount Hope, 2		40 26.52		14 26.09	do	Do.
Mumford, Cranston		46 13.10		33 15.83	do	Bull. 122.
Munroe (Borden)		46 34.35		19 05.61	do	Rept. '85.
Narragansett, church		29 33.60		25 33.46	do	Do.
Narragansett Bay, yellow barn cupola		41 01.77		27 13.58	do	Do.
Nayatt light-house (1863)		43 30.64		20 21.88	do	Do.
Nayatt light-house (1843)		43 30.09		20 22.31	do	Do.
Neutaconkanut		48 41.08		28 03.06	do	Do.
Newport:						
Bronson's house flagstaff		27 51.76		21 28.23	do	Do.
Church		29 14.46		18 49.71	do	Do.
Belmont's house cupola		27 52.17		18 22.46	do	Do.
Catholic church spire		28 49.06		18 49.38	do	Do.
Ocean House		28 53.24		18 30.59	do	Do.
New Weeden		22 54.29		33 16.31	do	Do.
North Popasquash		40 54.61		18 12.28	do	Do.
North Windmill		35 16.01		15 16.18	do	Do.
Northeast corner of Connecticut		01 24.82		48 04.20	do	Do.
Northwest corner of Rhode Island		00 29.15		47 58.92	do	Do.
Noyes Neck		19 46.49		45 19.84	do	Do.
Noyes Point		19 46.31		45 19.44	do	Do.

RHODE ISLAND—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			71°-72°				
	°	'	"	°	'	"		
Nye's (R.) house, white chimney	41	21	54.53	71	46	28.12	C. & G. S.	Rept. '85.
Paine		09	18.85		33	44.99	do	Do.
Pappoose Squaw		39	15.20		18	02.52	do	Do.
Pappoose Squaw, 2		39	15.20		18	02.45	do	Do.
Paradise Rock		30	05.51		15	45.50	do	Do.
Patience		39	33.47		21	24.58	do	Do.
Pawhungernock, church		30	20.06		50	25.46	do	Do.
Pawtucket:								
Spire		52	36.04		22	53.84	do	Do.
Dark spire		52	53.95		23	05.06	do	Do.
Pawtuxet		45	56.80		23	13.95	do	Do.
Borden		45	14.19		23	41.72	do	Do.
Beacon (1843)		45	35.56		22	50.95	do	Do.
Church spire		45	59.12		23	30.53	do	Do.
Peleg Tiff		23	18.75		48	40.42	do	Do.
Peirce:								
Barn		48	22.47		22	59.79	do	Do.
Barn cupola		25	34.08		28	50.74	do	Do.
Pine Hill		38	00.47		20	35.81	do	Do.
Pocasset		39	09.42		11	32.36	do	Do.
Point Judith		21	54.84		29	17.94	do	Do.
Light-house (1838)		21	39.88		28	54.73	do	Do.
Pojack		39	04.92		24	27.97	do	Do.
Pomham		46	42.15		21	28.04	do	Do.
Beacon (1843)		46	35.13		22	27.08	do	Do.
Poorhouse:								
Belfry		30	26.86		19	43.31	do	Do.
Northeast gable		35	21.98		24	50.76	do	Do.
Portsmouth, belfry		36	13.34		14	53.67	do	Do.
Portsmouth Grove, flagstaff		35	13.03		17	13.73	do	Do.
Potter's windmill shaft		30	56.30		22	28.66	do	Do.
Potter's (widow) barn		33	18.00		12	17.07	do	Do.
Potter's (A.) house chimney		30	29.90		21	38.60	do	Do.
Potter's (Dr.) house chimney		27	00.95		26	30.46	do	Do.
Prince		44	34.61		18	56.32	do	Do.
Prospect Hill		49	44.64		24	20.85	do	Do.
Providence:								
Baptist church		49	38.92		24	32.12	do	Do.
Congregational church		49	12.90		24	50.78	do	Do.
High Street church		49	05.73		25	16.25	do	Do.
Unitarian church		49	27.89		24	19.99	do	Do.
Quaker College		50	00.56		23	56.34	do	Do.
Vitriol works chimney		49	49.56		25	21.92	do	Do.
Prudence		36	24.42		18	42.59	do	Do.
2 (1869)		36	22.23		18	41.81	do	Do.
Island, light-house (1861)		36	21.34		18	14.46	do	Do.
Island, light-house (1869)		36	28.93		18	30.35	do	Do.
South		34	44.45		19	32.96	do	Do.
Quaker		34	57.38		15	18.34	do	Do.
Quonochontaug		19	59.99		42	37.33	do	Do.
Quonsett		35	28.58		24	33.70	do	Do.
Quonsett, 2		35	16.90		24	23.02	do	Do.
Quonsett, 3 (1868)		35	17.03		24	23.20	do	Bull. 122.
Reynolds		33	45.55		26	52.10	do	Rept. '85.
Rocky Point		41	29.72		21	50.03	do	Do.
Hotel chimney		41	21.91		21	56.52	do	Do.
Rose Island		29	48.20		20	34.44	do	Do.
Flagstaff		29	47.52		20	34.30	do	Do.
Rumstick		42	24.05		18	07.76	do	Do.
Sable Point		46	02.38		22	06.14	do	Do.
Sakonnet Point		27	16.36		11	46.09	do	Do.
Sanders's (E.) house chimney		20	26.32		44	46.60	do	Do.
Sandford, mill cupola		33	05.93		26	53.50	do	Do.
Sandhill		21	40.62		42	17.39	do	Do.
Sandy Point		39	43.29		24	37.14	do	Do.
Schoolhouse chimney		32	18.25		22	33.32	do	Do.
Seventh-Day meetinghouse, north chimney.		23	36.04		36	30.00	do	Do.
Shannock		28	05.19		38	21.49	do	Do.
Shaw's (Peter) barn cupola		29	14.50		08	45.72	do	Do.
Sherman		30	16.94		30	56.19	G. S.	Bull. 122.
Sherman		30	16.94		30	56.02	C. & G. S.	Rept. '85.
Sherman's (J. P.) house center chimney.		23	25.18		31	45.62	do	Do.
Sherman, house chimney		33	47.42		22	24.25	do	Do.
Signal flag		35	32.16		25	42.20	do	Do.
Simmons		29	32.29		09	34.21	do	Do.
Simmons, 2		29	32.08		09	34.66	do	Do.
Slate		32	21.01		15	59.64	do	Do.
Slate Hill, flagstaff (1869)		32	22.15		15	56.41	do	Do.
Smith, barn cupola		36	00.02		25	23.04	do	Do.

RHODE ISLAND—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			71°-72°				
	°	'	"	°	'	"		
South Portsmouth:								
Episcopal church tower.....	41	32	50.30	71	15	42.34	C. & G. S.	Rept. '85.
Union church tower.....		33	30.18		15	21.90	do	Do.
South Rock.....		34	26.66		25	03.67	do	Do.
Spar Island.....		41	17.40		13	14.68	do	Do.
Spencer.....		40	43.26		29	40.68	do	Do.
Spencer (2), Warwick.....		40	38.87		29	49.30	do	Bull. 122.
Stargut Island, house, north gable.....		47	10.00		22	55.92	do	Rept. '85.
Stevens.....		44	44.13		22	56.05	do	Do.
Sugarloaf Hill.....		26	04.96		30	40.02	do	Do.
Tefft:								
Barn cupola.....		31	32.92		25	34.92	do	Do.
House chimney.....		28	01.34		27	37.94	do	Do.
Telegraph.....		27	47.83		20	11.63	do	Do.
Telegraph, 2.....		27	47.28		20	11.61	do	Do.
Tiff.....		27	48.56		32	15.70	do	Bull. 122.
Tiverton, cupola.....		37	30.25		12	50.91	do	Rept. '85.
Topographical pole, near post road.....		23	41.82		35	54.60	do	Do.
Topographical pole, 3.....		23	17.94		35	17.72	do	Do.
Topographical pole, 4.....		23	59.28		32	40.78	do	Do.
Topographical pole, 6.....		24	00.68		33	31.32	do	Do.
Tourtellot, Gloucester.....		53	40.34		39	16.48	do	Bull. 122.
Tower Hill, church.....		28	02.85		27	35.23	do	Rept. '85.
Toweset.....		41	59.23		14	33.74	do	Do.
Toweset Neck (Borden).....		42	45.02		13	36.28	do	Do.
Vaughn, house cupola.....		34	25.62		27	45.68	do	Do.
Village Hill.....		20	54.17		44	59.29	do	Do.
Vue de l'Eau Hotel.....		47	15.82		22	05.09	do	Do.
Wakefield:								
Flagstaff.....		26	05.03		30	40.05	do	Do.
Church, gray spire.....		26	25.58		29	50.95	do	Do.
Church, white spire.....		26	24.25		30	11.06	do	Do.
Warren:								
Spire.....		43	48.47		17	04.14	do	Do.
Methodist spire.....		43	48.78		17	02.72	do	Do.
Beacon (1863).....		42	48.74		17	37.24	do	Do.
Warwick beacon (1843).....		39	25.02		23	36.17	do	Do.
Warwick light-house (1863).....		40	01.43		22	43.28	do	Do.
Warwick Neck.....		41	21.10		22	49.72	do	Do.
Watch Hill.....		18	49.93		51	17.20	do	Do.
Light-house.....		18	14.19		51	32.43	do	Do.
Watson, house chimney.....		28	22.37		26	05.70	do	Do.
Weaver, Coventry.....		39	37.21		39	49.84	do	Bull. 122.
Weeden.....		22	50.89		33	15.24	do	Rept. '85.
Well Hill.....		25	56.65		45	15.92	do	Do.
West.....		33	44.42		15	42.00	do	Do.
West Island, New York Club flag-staff (1869).....		27	00.81		11	59.03	do	Do.
Westerly.....		21	59.88		40	52.84	do	Do.
Wharton's (D.) house, east chimney.....		24	56.65		27	16.49	do	Do.
White House:								
West chimney.....		23	20.46		29	18.66	do	Do.
North chimney.....		40	46.09		27	04.36	do	Do.
Whitman.....		40	33.89		27	19.36	do	Do.
Wickford.....		34	30.54		28	02.69	do	Do.
Academy.....		34	06.68		27	21.19	do	Do.
Baptist church.....		34	19.58		27	05.35	do	Do.
Light-house (1868).....		34	15.92		26	22.59	do	Do.
Spire.....		34	23.40		27	00.02	do	Do.
Wilbur.....		29	29.63		38	32.54	do	Do.
Windmill.....		29	24.36		11	02.56	do	Do.
Wilcox.....		21	23.20		43	59.86	do	Do.
Windmill.....		32	33.62		11	50.48	do	Do.
Windmill, 2 (1869).....		32	33.56		11	50.51	do	Do.
Wing.....		35	23.22		11	10.35	do	Do.
Woonsocket.....		58	40.81		33	15.16	do	Bull. 122.
Yellow barn, cupola.....		22	31.40		37	26.60	do	Rept. '85.
Yellow house, chimney.....		43	41.87		19	23.20	do	Do.

CONNECTICUT.

	42°-43°			73°-74°				
	°	'	"	°	'	"		
Ball Peak, Mount Riga.....	42	00	43.33	73	27	57.84	C. & G. S.	Rept. '88.
Connecticut line (Borden).....		02	58.78		29	42.92	do	Do.
	41°-42°			71°-72°				
	°	'	"	°	'	"		
Atwoods, machine works cupola.....	41	19	49.32	71	54	26.23	do	Do.
Box Hill.....		47	59.79		27	21.40	do	Bull. 122.

CONNECTICUT—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			71°-72°				
	°	'	"	°	'	"		
Chapman Hill.....	41	29	32.28	71	51	40.57	C. & G. S.	Bull. 122.
Eels Hill, 2.....		22	49.87		51	04.35	do	Rept. '85.
Frost.....		20	57.57		51	03.25	do	Rept. '88.
Grant Hill.....		25	25.17		54	06.05	do	Do.
Jesse Main.....		26	31.63		49	15.00	do	Do.
Lantern Hill.....		27	37.93		56	40.83	do	Do.
Morgan Point, light-house (1874-1886).....		18	59.43		59	23.67	do	Do.
Mount Riga (on Ball Peak).....		00	43.33		27	57.84	do	Rept. '85.
Noank, spire (1882).....		19	33.76		59	13.14	do	Do.
North Stonington.....		25	59.53		51	20.72	do	Do.
Northeast corner of Connecticut (Borden).....		01	24.82		48	04.20	do	Do.
Palmer.....		21	37.29		55	41.92	do	Rept. '88.
Portersville, spire (1835).....		21	14.80		58	24.87	do	Do.
Powhungemock church (1838).....		30	20.06		50	25.46	do	Do.
Quacatog.....		23	15.29		56	58.57	do	Do.
Ram Island:								
Hotel flagstaff.....		18	40.34		58	46.45	do	Do.
Reef Spindle (1835).....		18	23.16		58	29.42	do	Do.
Road Meetinghouse (1838).....		22	23.44		54	51.18	do	Do.
Sandford.....		27	42.80		56	59.30	do	Rept. '85.
Stonington:								
Meetinghouse (1835).....		20	12.24		54	21.08	do	Rept. '88.
Harbor, light-house (1873-1886).....		19	42.72		54	21.59	do	Do.
Walnut Hill.....		25	14.80		54	35.66	do	Do.
Wamposset.....		19	44.65		55	16.93	do	Do.
Wilcox, fish works, brick chimney.....		19	59.45		57	13.04	do	Do.
	41°-42°			72°-73°				
	°	'	"	°	'	"		
Allen.....	41	17	40.30	72	58	23.88	do	Do.
Arnold Quarry.....		28	26.06		30	28.54	do	Do.
Avery Hill.....		28	02.99		02	58.71	do	Do.
Avery Hill, 2.....		20	21.52		04	05.25	do	Do.
Avery Point.....		18	57.59		03	52.58	do	Do.
Avery Point, 2 (1882).....		18	57.02		03	52.68	do	Do.
Ayer.....		19	55.92		21	38.38	do	Do.
Bailey.....		22	51.64		04	56.93	do	Do.
Bald Hill.....		58	25.89		11	55.03	do	Bull. 122.
Do.....		27	43.10		25	06.86	do	Rept. '88.
Baldwin.....		24	06.00		04	40.25	do	Do.
Barker.....		15	15.84		48	34.22	do	Do.
Bartlett.....		14	54.10		42	44.85	do	Do.
Beacon.....		18	48.03		03	58.98	do	Do.
Hill.....		17	34.65		24	08.85	do	Do.
Hill, 3 (1882).....		17	34.38		24	09.32	do	Do.
Beckwith.....		21	12.50		21	23.04	do	Do.
Bethany:								
Church spire.....		25	30.92		59	47.33	do	Do.
South.....		23	34.15		58	03.90	do	Do.
Bigelow's house, chimney.....		18	09.63		54	04.21	do	Do.
Bill Hill.....		20	11.29		59	08.35	do	Do.
Block Point.....		17	09.68		12	19.75	do	Do.
Block Point, 2 (1882).....		17	11.78		12	17.37	do	Do.
Bluff Point.....		18	53.97		02	04.97	do	Do.
Bog Hole Hill.....		18	49.74		18	56.90	do	Do.
Bog Hole Hill, 2 (1861).....		18	49.74		18	56.95	do	Do.
Bolles Hill.....		27	49.24		04	43.04	do	Do.
Book Hill.....		22	06.53		24	47.38	do	Do.
Boulder.....		14	34.79		42	21.46	do	Do.
Bradley.....		17	14.20		49	28.04	do	Do.
Brainerd.....		29	18.49		31	35.95	do	Do.
Branford, Congregational church spire (1876).....		16	52.22		48	40.61	do	Do.
Branford Reef, beacon (1881-1882).....		13	16.78		48	20.68	do	Do.
Brethren.....		24	53.18		55	48.69	do	Do.
Brewster's Factory cupola.....		18	09.46		54	38.72	do	Do.
Bridge.....		17	33.28		55	59.19	do	Do.
Broadway church.....		31	34.05		04	33.65	do	Do.
Brockway.....		23	23.64		23	18.73	do	Do.
Brooks.....		25	24.26		25	42.99	do	Do.
Browning.....		25	05.54		06	23.63	do	Do.
Buckingham.....		22	56.35		23	47.90	do	Do.
C.....		16	14.33		54	21.20	do	Do.
Camp Hill.....		16	30.41		34	13.41	do	Do.
Canal Dock.....		17	38.30		54	52.73	do	Do.
Case.....		22	31.63		53	32.34	do	Do.
Cedar.....		31	08.33		05	25.87	do	Do.
Do.....		22	41.98		23	40.05	do	Do.
Do.....		17	43.14		57	44.57	do	Do.
Centerville, church.....		23	01.59		54	11.50	do	Do.
Champion House flagstaff.....		27	42.76		27	53.32	do	Do.
Chapin.....		18	01.01		06	45.28	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			72°-73°				
	°	'	"	°	'	"		
Charleston, cupola.....	41	31	41.22	72	04	50.63	C. & G. S.	Rept. '88.
Chemical works ventilator.....		16	07.90		54	07.34	do	Do.
Cheshire, church spire.....		29	52.78		54	12.18	do	Do.
Chester:								
Landing.....		24	50.52		25	45.96	do	Do.
Spire.....		24	04.64		27	15.16	do	Do.
Chestnut, 1 (1875).....		21	56.86		57	05.62	do	Do.
Chestnut, 2 (1875).....		23	12.86		55	28.34	do	Do.
Chestnut Hill.....		31	27.38		25	53.56	do	Do.
Clark Point.....		14	00.32		58	43.15	do	Do.
Clinton, church spire (1882).....		16	39.89		31	38.74	do	Do.
Cornfield Point.....		15	42.21		23	14.28	do	Do.
Cornfield Point, 2 (1882).....		15	42.48		23	14.73	do	Do.
Cone.....		24	38.76		26	52.80	do	Do.
Do.....		17	55.09		50	58.03	do	Do.
Corner stone.....		24	03.62		05	27.44	do	Do.
Cow Hill.....		17	44.40		32	29.65	do	Do.
Cow Point.....		24	32.33		05	33.94	do	Do.
Crane Bar.....		17	03.14		54	13.95	do	Do.
Cromwell, Congregational church.....		35	48.75		38	46.76	do	Do.
Deep River spire.....		23	12.14		26	04.78	do	Do.
Dickerman.....		25	06.94		55	42.34	do	Do.
Dike.....		17	01.99		56	16.54	do	Do.
Doane.....		22	27.19		24	47.58	do	Do.
Doolittle.....		22	25.18		58	48.29	do	Do.
Dragon, brick church, spire.....		18	35.18		53	26.31	do	Do.
Duck Island.....		15	23.67		28	33.14	do	Do.
Duck Island, 2 (1882).....		15	23.91		28	33.26	do	Do.
Fair Haven:								
Spire.....		18	35.20		53	26.33	do	Do.
Second Congregational church.....		18	27.90		53	08.81	do	Do.
Falkner Island, light-house (1833-1882).....		12	43.18		39	14.45	do	Do.
Falls liberty pole.....		32	08.89		05	28.42	do	Do.
Fellows.....		31	06.86		04	09.50	do	Do.
Fenwick Hall, flagstaff.....		16	20.43		21	15.03	do	Do.
Ferry.....		18	57.92		21	56.98	do	Do.
Ferry, 2 (1861).....		18	57.91		21	57.00	do	Do.
Fish house.....		15	49.62		27	53.71	do	Do.
Flagstaff.....		31	01.07		04	53.78	do	Do.
East.....		16	58.77		53	58.50	do	Do.
East Haddam:								
Congregational church.....		28	49.29		26	48.97	do	Do.
Episcopal church.....		27	37.70		27	33.73	do	Do.
East Hartford, square steeple, green blinds.....		46	08.56		38	41.38	do	Do.
East Haven:								
Flagstaff (1875).....		16	32.08		52	04.15	do	Do.
Spire.....		16	41.82		52	19.72	do	Do.
East Rock.....		19	37.42		54	17.44	do	Do.
East Rock, 2 (1871).....		19	42.43		54	26.32	do	Do.
Edgecombe House, flagstaff.....		19	31.46		04	31.67	do	Do.
Ely.....		21	51.48		22	27.20	do	Do.
Ely, 2 (1861).....		21	51.48		22	27.19	do	Do.
Ely, 3 (1861).....		21	52.97		22	24.74	do	Do.
Emmons.....		32	06.35		32	07.63	do	Do.
Essex.....		20	33.36		23	49.09	do	Do.
Baptist church.....		21	18.26		23	33.57	do	Do.
Congregational church.....		21	09.96		23	34.24	do	Do.
Episcopal church (1861).....		21	11.08		23	32.43	do	Do.
Essex, 2 (1861).....		20	33.33		23	49.09	do	Do.
Forbes.....		17	47.40		54	07.40	do	Do.
Fort Hale, 2 (1874).....		16	14.79		54	18.57	do	Do.
Fort Hill, 2 (1882).....		20	47.82		00	40.65	do	Do.
Fort Trumbull, flagstaff (1882).....		20	38.28		05	39.16	do	Do.
Fort Wooster, 3 (1882).....		16	55.92		53	35.12	do	Do.
Four Mile River, 2 (1882).....		18	12.40		16	13.48	do	Do.
Fresenius Brewery cupola.....		17	56.34		56	36.16	do	Do.
Gelston.....		26	57.58		26	31.49	do	Do.
Giant Head.....		25	35.82		53	59.06	do	Do.
Goshen.....		17	57.65		06	47.94	do	Do.
Granby.....		55	57.08		53	18.88	G. S.	Bull. 122.
Grassy Hill, church.....		23	45.56		17	16.50	C. & G. S.	Rept. '88.
Gravel Bluff.....		19	20.44		21	05.84	do	Do.
Graves.....		17	52.84		36	51.65	do	Do.
Great Hummock.....		15	35.22		30	43.34	do	Do.
Great Rock.....		20	31.54		51	11.30	do	Do.
Green Hill.....		49	00.26		23	14.32	G. S.	Bull. 122.
Griswold.....		17	30.24		39	36.26	C. & G. S.	Rept. '88.
Groton Hill.....		22	38.27		04	54.20	do	Do.
Groton Long Point.....		18	26.80		00	21.29	do	Do.
Groton Long Point, 2 (1882).....		18	25.09		00	19.93	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			72°-73°				
	°	'	"	°	'	"		
Groton Monument	41	21	18.02	72	04	47.45	C. & G. S.	Rept. '88.
Grove		19	02.97		52	57.23	do	Do.
Guard House Point, chimney		15	51.14		22	04.12	do	Do.
Haddam:								
Academy		28	44.81		30	59.76	do	Do.
Congregational church		28	45.82		30	56.05	do	Do.
Court-house		28	50.68		31	00.62	do	Do.
Haddam Neck		28	55.33		29	28.36	do	Do.
Congregational church		31	47.50		32	13.46	do	Do.
Methodist church		30	54.47		30	53.26	do	Do.
Flag		29	37.60		30	30.18	do	Do.
Hadlyme, church cupola		25	53.58		24	21.36	do	Do.
Hamburg Cove		22	36.66		22	21.00	do	Do.
Hamden Methodist church		21	11.38		55	53.14	do	Do.
Hammonasset, hotel chimney		16	17.35		35	10.39	do	Do.
Hammonasset, 2 (1882)		14	55.84		32	40.59	do	Do.
Harrison		18	00.48		49	45.16	do	Do.
Hartford:								
South Congregational church		45	34.82		40	33.35	do	Do.
Arsenal flagstaff		46	51.85		40	34.00	do	Do.
Colt's factory		45	24.28		39	48.90	do	Do.
Old State House cupola		45	58.03		40	23.38	do	Do.
Windsor avenue church		46	56.74		40	33.74	do	Do.
Hatchett Point		16	58.81		15	43.53	do	Do.
Hatchett Point, 2 (1882)		17	03.53		15	45.75	do	Do.
Hayden Point		20	37.22		22	38.52	do	Do.
Hemlock		22	27.28		59	03.64	do	Do.
Hemmingway		18	58.19		52	12.37	do	Do.
Hen and Chickens beacon (1882)		15	12.16		24	18.33	do	Do.
Higganum:								
Congregational church		29	51.13		33	20.29	do	Do.
Methodist church		29	54.66		33	49.49	do	Do.
High Hill		20	37.57		37	41.95	do	Do.
Highlands		15	56.18		38	57.53	do	Do.
High Rock		24	18.25		56	07.91	do	Do.
Hillhouse		19	40.61		59	48.57	do	Do.
Hillside		22	52.58		57	57.35	do	Do.
Hoadley Neck		15	27.53		44	10.04	do	Do.
Hogshead Point		16	10.60		38	15.26	do	Do.
Holt		25	41.32		27	29.89	do	Do.
Honey Hill		23	49.83		21	34.38	do	Do.
Horse Pond		17	36.20		35	20.92	do	Do.
Horse, cupola of house		14	39.86		45	31.03	do	Do.
Hotchkiss		23	43.87		58	53.50	do	Do.
Howard, 1 (1876)		24	31.72		52	18.81	do	Do.
Howard, 2 (1877)		24	51.14		52	33.05	do	Do.
Huddenston		26	57.06		58	24.78	do	Do.
Hungry Hill		18	49.90		41	33.02	do	Do.
Ives cupola		18	31.69		52	52.00	do	Do.
Indian Neck		15	23.82		49	19.76	do	Do.
Insane asylum, northwest chimney		33	08.02		37	50.08	do	Do.
Jail Hill		31	41.16		04	49.15	do	Do.
Jeremy:								
North		16	13.51		56	03.18	do	Do.
South		15	39.47		56	02.96	do	Do.
Jewett		18	46.91		58	22.14	do	Do.
Joe Post light (1861)		23	20.35		25	05.28	do	Do.
Johnny Cake		45	12.79		59	41.01	G. S.	Bull. 122.
Jones		27	59.34		27	32.46	C. & G. S.	Rept. '88.
Do		15	37.80		58	25.79	do	Do.
Jordan, church tower		18	31.00		07	42.35	do	Do.
Joshua Rock		22	51.84		22	37.80	do	Do.
Kelsey Clinton		15	24.44		30	27.65	do	Do.
Kelsey Westbrook		16	27.00		25	28.46	do	Do.
Kongscut		41	44.35		30	10.15	do	Do.
Lancrofts, cupola		18	05.15		53	17.68	do	Do.
Lay Hill		16	58.26		18	02.04	do	Do.
Lay Hill, 2 (1861)		16	58.20		18	02.06	do	Do.
Lay Hill, 3 (1882)		16	57.93		18	01.84	do	Do.
Lebanon		26	26.56		59	38.96	do	Do.
Ledge		25	07.39		05	17.74	do	Do.
Lewis		19	14.73		12	03.15	do	Do.
Lewis Grove		16	16.03		29	08.62	do	Do.
Locust		25	02.22		27	17.72	do	Do.
Long Hill		26	45.49		30	24.97	do	Do.
Do		17	26.35		30	47.08	do	Do.
Do		24	08.31		53	09.57	do	Do.
Lord		21	30.88		20	47.42	do	Do.
Lower Pole Hill		27	11.69		07	31.19	do	Do.
Lyne, white Congregational church (1835-1883)		18	46.45		19	56.04	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			72°-73°				
	°	'	"	°	'	"		
Madison :								
Church spire (1838)	41	16	44.80	72	36	08.35	C. & G. S.	Rept. '88.
Congregational church spire (1882)		16	47.90		36	12.79	do	Do.
Malicah		20	35.17		20	09.23	do	Do.
Manetuck		21	15.56		09	03.16	do	Do.
Manetuck, 2 (1882)		21	15.26		09	03.53	do	Do.
Mansfield		21	52.39		50	20.97	do	Do.
Mason		30	30.13		04	41.83	do	Do.
Maynard		26	10.51		04	14.49	do	Do.
Meeting House Hill		36	08.68		08	38.97	G. S.	Bull. 122.
Menunketesuck		15	42.73		27	48.99	C. & G. S.	Rept. '88
Merritt		24	23.65		56	30.69	do	Do.
Middletown :								
Catholic church		33	59.08		39	11.92	do	Do.
Indian Hill Cemetery, summer-house.		33	17.08		39	48.19	do	Do.
North Congregational church		33	36.59		39	05.42	do	Do.
South Congregational church		33	23.25		38	51.74	do	Do.
Wesleyan College chapel		33	20.72		39	23.04	do	Do.
Mill Rock		16	48.22		51	47.65	do	Do.
Millstone Point		18	18.92		09	54.44	do	Do.
House, west chimney		18	30.40		10	08.21	do	Do.
Mohican :								
Church spire (1838)		28	23.88		05	55.31	do	Do.
Church spire (1874)		28	23.90		05	55.40	do	Do.
Montowese church		20	55.49		51	45.80	do	Do.
Morgan Point		14	32.70		53	39.53	do	Do.
Moose Hill, New Haven		18	22.56		44	34.18	do	Do.
Moodus		31	13.47		27	32.64	do	Do.
Mound		30	32.65		05	13.43	do	Do.
Mount Carmel		25	51.80		53	25.64	do	Do.
Mount Ephraim		27	47.45		54	56.64	do	Do.
Mount Parnassus		28	03.61		24	40.54	do	Do.
Mount Prospect		28	22.70		58	16.34	do	Do.
Mulberry Point		15	37.52		40	55.47	do	Do.
Murdock		17	10.50		28	20.94	do	Do.
Murdock, 2 (1882)		17	06.83		28	21.73	do	Do.
New England Cement Works, smoke-stack.		22	36.18		58	39.97	do	Do.
New Haven :								
First Congregational church		18	34.78		53	38.15	do	Do.
Baptist church		18	33.50		53	23.82	do	Do.
Light-house (1833-1882)		14	56.40		54	15.13	do	Do.
City Hall		18	26.57		55	29.87	do	Do.
Almshouse cupola		18	55.57		57	08.48	do	Do.
Scientific School, observatory tower.		18	42.77		55	32.63	do	Do.
St. Paul's Episcopal church, southwest spire.		18	13.74		55	13.86	do	Do.
St. Patrick's church		18	30.72		54	42.41	do	Do.
Grace church		18	25.50		53	57.08	do	Do.
South church		17	53.48		55	52.88	do	Do.
Custom-House Square, flagstaff		18	02.82		55	26.63	do	Do.
Schoolhouse cupola		18	35.19		53	26.32	do	Do.
Long Wharf light-house (1873)		17	33.82		54	56.49	do	Do.
New London :								
First Congregational church (1882).		21	18.23		05	50.38	do	Do.
Second Congregational church (1882).		21	26.34		06	06.30	do	Do.
Light-house (1835-1886)		18	59.99		05	24.68	do	Do.
Niantic, spire		19	39.00		11	35.04	do	Do.
Nickerson		23	53.85		19	39.56	do	Do.
No Name		26	41.35		57	30.62	do	Do.
North		17	35.88		54	15.85	do	Do.
North Glastonbury, Congregational church.		42	31.86		36	31.92	do	Do.
North Guilford church spire		22	05.84		43	39.44	do	Do.
North Haven church spire		23	12.97		51	42.66	do	Do.
North Hill		22	36.82		49	18.43	do	Do.
North Killingworth, Congregational church (1836-1882).		21	47.07		33	58.07	do	Do.
North Pond Rock		19	00.52		50	17.48	do	Do.
North Quinnipiac		19	28.71		53	20.77	do	Do.
North Sheffield College :								
Larger observatory in college grounds.		18	47.00		55	30.89	do	Do.
South chimney lightning rod		18	45.96		55	31.67	do	Do.
North watchhouse		16	44.40		55	09.49	do	Do.
Norwich church		32	57.64		05	46.78	do	Do.
Noyes		18	59.61		20	33.18	do	Do.
Ogden		23	48.29		05	24.44	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			72°-73°				
	°	'	"	°	'	"		
Orange	41	17	58.04	72	57	54.16	C. & G. S.	Rept. '88.
Oyster Point		16	58.47		55	48.98	do	Do.
Oyster River Point		14	02.20		58	33.11	do	Do.
Paddock		16	25.92		34	13.68	do	Do.
Page		19	22.92		48	11.92	do	Do.
Paphro		28	40.41		31	30.35	do	Do.
Park church		32	07.87		04	55.05	do	Do.
Peak		57	32.48		44	24.02	G. S.	Bull. 122.
Peck street		19	02.44		53	19.01	C. & G. S.	Rept. '88.
Penfield Hill		34	54.05		34	29.77	do	Do.
Pettipaug spire		21	05.94		24	53.38	do	Do.
Pilgrim		19	49.60		20	27.46	do	Do.
Pine		21	59.66		58	25.68	do	Do.
Hill		36	37.64		32	11.98	do	Do.
Island		20	26.14		20	50.95	do	Do.
Street		18	47.78		53	16.56	do	Do.
Pinnacle		18	58.65		51	00.62	do	Do.
Plant Hill		16	39.10		50	29.84	do	Do.
Pole		27	14.52		07	41.57	do	Do.
Pond Lily Paper Mill, chimney		20	06.59		58	35.00	do	Do.
Pond Rock		17	40.04		51	24.46	do	Do.
Poorhouse flagstaff		21	08.51		06	41.80	do	Do.
Poplar		16	30.49		50	22.65	do	Do.
Poplar, 2 (1882)		16	30.47		50	22.65	do	Do.
Portland :								
White steeple		34	53.00		38	03.12	do	Do.
Congregational church		35	28.58		37	29.55	do	Do.
Schneider's factory smokestack		34	14.78		37	45.68	do	Do.
Post		13	22.33		59	40.60	do	Do.
Post Hill		40	15.15		20	19.64	G. S.	Bull. 122.
Prindle		16	05.12		59	32.63	C. & G. S.	Rept. '88.
Prospect church spire		30	07.69		58	41.88	do	Do.
Quaker		22	46.37		06	26.05	do	Do.
Quarry		24	26.72		25	17.11	do	Do.
Do		15	26.37		43	59.37	do	Do.
Quartz Hill		22	00.41		59	41.37	do	Do.
Rabbit Rock		20	31.63		51	12.19	do	Do.
Red and White		17	07.05		53	49.07	do	Do.
Road		24	18.51		56	40.25	do	Do.
Robinson Hill		47	43.61		04	48.29	G. S.	Bull. 122.
Rock		31	10.98		04	13.18	C. & G. S.	Rept. '88.
Rocky Ledge		18	30.73		15	01.16	do	Do.
Rogers, Smith & Co., cupola		18	09.46		54	38.76	do	Do.
Round Hill House		17	41.00		58	23.73	do	Do.
Sachem Head		16	58.58		43	30.78	do	Do.
Salmon		28	19.33		28	00.52	do	Do.
Sandford (1839)		28	07.64		57	13.78	do	Do.
Sandford Az. Station (1862)		27	42.80		56	59.30	do	Do.
Sandford Lat. Station (1862)		27	43.19		56	59.85	do	Do.
Sandy Point		16	04.16		55	35.10	do	Do.
Saybrook :								
Beacon (1882-83)		16	07.50		20	18.70	do	Do.
Light-house (1835-36)		16	17.65		20	36.94	do	Do.
Breakwater light-house (1886)		15	47.69		20	35.45	do	Do.
Congregational church (1861-1883)		17	12.20		22	32.29	do	Do.
Light-house (1861-1886)		16	17.39		20	36.86	do	Do.
Schoolhouse		30	54.32		04	32.55	do	Do.
Schoolhouse Hill		39	31.32		40	52.91	do	Do.
Selden		24	20.24		24	02.76	do	Do.
Selden Neck		23	43.05		24	54.72	do	Do.
Selden North		30	50.16		31	30.07	do	Do.
Setauket		19	36.49		46	32.11	do	Do.
Shailerville, Baptist church		27	55.48		28	47.96	do	Do.
Shaler		27	47.93		29	00.93	do	Do.
Shell Heap		18	43.58		52	58.94	do	Do.
Shipman		40	16.02		38	14.37	do	Do.
Simpson		37	58.08		36	47.82	do	Do.
Slate Hill		22	28.22		58	52.19	do	Do.
Slaughterhouse, east cupola		19	17.26		53	33.27	do	Do.
Smith		30	32.05		30	55.32	do	Do.
Smith Landing		29	07.76		30	26.30	do	Do.
Soapstone		57	32.50		24	49.30	G. S.	Bull. 122.
South Pond Rock		17	05.89		51	49.89	C. & G. S.	Rept. '88.
Southwest Ledge, light-house (1875-1882)		14	04.14		54	45.08	do	Do.
Sperry		21	06.84		59	14.60	do	Do.
Spink Hill		16	37.70		50	58.79	do	Do.
Steens		37	19.70		40	47.26	do	Do.
Stone Hill		19	54.15		24	11.31	do	Do.
Storr Monument		48	52.51		15	33.98	do	Do.
St. Francis Orphan Asylum, cupola		19	43.78		55	07.62	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	41°-42° ° / "	72°-73° ° / "		
Stony Creek.....	41 16 23.30	72 45 21.29	C. & G. S.	Rept. '88.
Sugarloaf.....	22 31.86	43 54.97	do	Do.
Swan Hill.....	30 09.02	33 31.89	do	Do.
Sweet Hill.....	40 15.88	13 49.55	G. S.	Bull. 122.
Talcott.....	48 41.64	47 57.19	C. & G. S.	Rept. '88.
Taylor.....	40 19.05	35 25.38	do	Do.
Telegraph.....	17 09.92	55 52.59	do	Do.
Telegraph rod.....	18 56.81	53 14.72	do	Do.
Thayer.....	31 55.85	35 07.14	do	Do.
Thompson.....	19 42.10	49 58.20	do	Do.
Tory.....	31 04.44	04 05.33	do	Do.
Town Post.....	15 27.60	43 54.11	do	Do.
Tryon.....	32 40.58	37 37.73	do	Do.
Tulip tree.....	21 47.87	54 00.68	do	Do.
Tuxis Island.....	15 57.89	36 08.32	do	Do.
Tuxis Island, 2 (1882).....	15 57.09	36 06.35	do	Do.
Two Tree Island.....	17 40.82	09 11.98	do	Do.
Two Tree Island, 2 (1882).....	17 39.16	09 11.03	do	Do.
Two Tree Island House.....	17 40.18	09 11.37	do	Do.
Uncas Hill.....	28 14.90	05 27.62	do	Do.
Uncasville church.....	26 17.86	06 27.17	do	Do.
Upper Pole Hill.....	27 14.38	07 41.13	do	Do.
Vinegar Hill.....	25 27.37	03 21.53	do	Do.
Wadsworth tower (1875).....	49 25.60	47 56.82	do	Do.
Wahginicut.....	23 43.60	25 45.92	do	Do.
Walden Island.....	28 06.55	04 08.33	do	Do.
Walkley.....	29 42.40	32 02.09	do	Do.
Wallingford church spire.....	27 15.75	49 08.42	do	Do.
Watch House.....	15 14.99	40 39.13	do	Do.
Water.....	17 20.00	55 40.34	do	Do.
West, 1 (1869).....	23 28.90	05 45.30	do	Do.
West, 2 (1869).....	24 04.40	05 55.66	do	Do.
West, 3 (1869).....	24 26.68	05 54.99	do	Do.
Westbrook, Congregational church (1861-1882).....	17 10.64	27 00.73	do	Do.
Westfield.....	33 31.17	42 34.15	do	Do.
West Haven spire (1833).....	16 17.67	57 02.98	do	Do.
West Haven:				
Key Works, chimney.....	16 46.26	56 25.12	do	Do.
Congregational church (1876).....	16 17.48	57 01.88	do	Do.
West Peak.....	33 34.90	50 38.78	G. S.	Bull. 122.
West Rock.....	19 56.42	57 42.61	C. & G. S.	Rept. '88.
West Rock (1882).....	15 12.75	32 01.71	do	Do.
West Rock, 2 (1871).....	19 56.42	57 42.00	do	Do.
West Rock North.....	22 58.88	57 44.84	do	Do.
West Rock North, 2 (1875).....	23 21.94	57 34.93	do	Do.
West Rock Ridge.....	25 07.75	57 18.83	do	Do.
West Side church.....	31 19.35	04 58.70	do	Do.
Westville.....	19 35.65	58 16.80	do	Do.
Methodist Episcopal church.....	19 42.80	57 41.27	do	Do.
Wethersfield:				
Flagstaff (1875).....	42 45.90	39 10.97	do	Do.
White Congregational church.....	42 46.70	39 09.60	do	Do.
Williams.....	21 18.95	31 09.57	do	Do.
Dock.....	21 37.88	23 28.60	do	Do.
Willow.....	29 44.08	04 28.80	do	Do.
Winchester Hill.....	19 28.04	55 18.96	do	Do.
Wire works.....	17 56.08	53 43.65	do	Do.
Yale College, middle spire.....	18 30.12	55 44.46	do	Do.
Yale Observatory:				
Center peg.....	19 28.48	55 19.16	do	Do.
East dome apex.....	19 28.48	55 18.06	do	Do.
York Hill.....	24 32.06	55 09.79	do	Do.
	41°-42° ° / "	73°-74° ° / "		
Adams.....	41 09 03.40	73 19 36.48	do	Do.
Americus, tower of Indian Harbor hotel.....	00 37.27	37 09.36	do	Do.
Baker.....	18 29.29	31 20.28	do	Do.
Bald Hill.....	12 49.82	28 41.68	do	Bull. 122.
Bald Hill, 2 (1882).....	12 49.82	28 41.71	do	Rept. '88.
Barn Hill.....	20 40.42	11 06.77	do	Do.
Beach Point.....	07 41.46	14 33.38	do	Do.
Bell Island.....	03 19.80	26 01.76	do	Do.
Benedict.....	04 24.94	28 23.74	do	Do.
Bennet.....	16 40.12	06 05.81	do	Do.
Blackburn.....	21 35.34	11 43.14	do	Do.
Black Rock (1833).....	08 38.92	12 57.24	do	Do.
Black Rock, 2 (1834).....	08 35.04	12 58.13	do	Do.
Black Rock:				
Light-house (1833-1835).....	08 32.58	13 04.09	do	Do.
Beacon.....	07 14.36	13 03.79	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			73°-74°				
	°	'	"	°	'	"		
Booth.....	41	16	42.43	73	11	06.28	C. & G. S.	Rept. '88.
Bradley.....		10	53.83		17	30.54	do	Do.
Bridgeport:								
Harbor light-house (1882).....		09	24.18		10	49.38	do	Do.
Inner northeast beacon (1833-1882).....		09	58.88		10	35.60	do	Do.
Outer southwest beacon (1833-1882).....		09	47.01		10	45.86	do	Do.
Second Congregational church spire (1882).....		10	32.60		11	24.26	do	Do.
First Congregational church spire (1882).....		10	37.60		11	26.42	do	Do.
First Presbyterian church spire (1882).....		10	29.30		11	42.32	do	Do.
Harbor light-house (1853).....		09	26.26		10	48.40	do	Do.
Middle steeple (1833).....		10	34.76		11	24.83	do	Do.
North steeple (1833).....		10	37.64		11	26.53	do	Do.
St. Augustine Catholic church spire (1882).....		10	48.70		11	45.00	do	Do.
South steeple (1833).....		10	32.51		11	23.95	do	Do.
Brown.....		10	01.82		25	47.64	do	Do.
Brushy Ridge.....		09	24.29		29	00.90	do	Do.
Burns Point.....		12	37.34		03	01.45	do	Do.
Calf Pasture Island.....		04	56.36		23	03.57	do	Do.
Canal.....		05	58.33		22	26.19	do	Do.
Center Redding.....		19	00.62		22	57.91	do	Do.
Charles Island, poplar.....		11	28.16		03	18.96	do	Do.
Chestnut.....		14	13.50		14	14.61	do	Do.
Chestnut Tree Hill.....		26	26.53		05	42.48	do	Do.
Chimon Island (1834).....		04	03.24		23	29.30	do	Do.
Chimon Island, 2 (1882).....		04	04.78		23	29.37	do	Do.
Close.....		04	47.84		38	03.75	do	Do.
Cobble.....		46	37.15		30	04.53	do	Do.
Cockenoes.....		05	01.42		21	20.76	do	Do.
Cockenoes Island, 2 (1882).....		05	01.40		21	21.08	do	Do.
Collins.....		26	20.28		00	44.90	do	Do.
Connecticut.....		57	28.35		29	37.59	do	Do.
Connecticut Monument.....		57	30.00		29	37.56	do	Do.
Copp Island (1834-1885).....		03	34.41		23	15.48	do	Do.
Coram.....		17	52.72		05	04.11	do	Do.
Cronch.....		17	08.85		25	56.32	do	Do.
Cumpo (1834).....		06	50.04		21	00.52	do	Do.
Cumpo, 2 (1882).....		06	49.23		20	58.11	do	Do.
Danbury, Congregational church (1864).....		23	39.87		27	11.87	do	Do.
Davenport.....		07	34.72		31	42.73	do	Do.
Dead Tree Hill.....		17	13.17		18	59.50	do	Do.
Dorlon's Hotel, cupola.....		05	13.21		24	07.70	do	Do.
Dye works, southwest chimney.....		02	52.30		30	15.60	do	Do.
East Bridgeport, Catholic church spire (1884).....		10	54.55		10	44.72	do	Do.
Easton spire (1839).....		15	01.63		18	10.59	do	Do.
Ellsworth.....		48	07.78		27	12.47	do	Do.
Fairfield.....		09	23.92		15	33.68	do	Do.
Congregational church spire (1882).....		08	35.56		15	02.06	do	Do.
Episcopal church spire (1882).....		08	32.58		15	02.89	do	Do.
Presbyterian church spire (1833).....		08	35.99		15	01.57	do	Do.
Ferris, cupola of "Old Greenwich Pt. House.".....		01	04.14		33	49.71	do	Do.
Field Point.....		00	06.50		37	37.92	do	Do.
Fish Island.....		02	54.35		27	28.32	do	Do.
Frost Point.....		06	55.52		18	34.71	do	Do.
Frost Point, 2 (1882).....		06	55.46		18	33.78	do	Do.
Good Hill.....		32	55.52		15	36.75	do	Bull. 122.
Goodridge.....		19	41.89		18	49.19	do	Rept. '88.
Goodsall.....		15	58.50		24	55.52	do	Do.
Gorham.....		11	00.29		23	45.68	do	Do.
Goshen Center Congregational church (1865).....		49	54.11		13	30.74	do	Do.
Gould.....		10	58.50		16	38.38	do	Do.
Great Hill, east.....		21	53.66		07	01.36	do	Do.
Green Farms, spire (1834).....		08	09.62		19	50.77	do	Do.
Green Ledge Spindle.....		02	36.35		25	22.57	do	Do.
Greenfield.....		11	32.29		17	18.69	do	Do.
Church spire (1882).....		10	36.82		17	34.19	do	Do.
Church spire (1833).....		10	37.06		17	34.21	do	Do.
Greenwich Point.....		00	09.90		34	17.40	do	Do.
Greenwich Point, 2 (1882).....		00	14.20		34	26.13	do	Do.
Gunn.....		13	56.53		04	57.96	do	Do.
Handford.....		09	06.74		22	27.02	do	Do.
Hawley.....		19	17.46		14	55.50	do	Do.
Hickcox.....		23	12.43		00	13.53	do	Do.
Hickcox (1839-1876).....		23	12.75		00	13.75	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			73°-74°				
	°	'	"	°	'	"		
High Ridge	41	16	24.20	73	30	09.06	C. & G. S.	Rept. '88.
Hitchcock		48	04.49		29	42.13	do	Do.
Hobby		03	35.28		36	59.41	do	Do.
Hooper		24	56.46		00	03.97	do	Do.
Horseneck, First Congregational church spire.		02	07.19		37	24.64	do	Do.
Horseneck, spire (1833)		02	06.08		37	24.46	do	Do.
Hospital		11	21.21		10	00.76	do	Do.
Hunt		18	24.28		32	54.32	do	Do.
Ivy		52	18.50		13	27.93	do	Rept. '85.
Jackson		15	06.59		17	00.41	do	Rept. '88
Johnson		10	04.88		10	04.08	do	Do.
Kensies Point		07	33.24		16	22.52	do	Do.
Lambert		48	10.94		30	13.25	do	Do.
Litchfield:								
Congregational church (1865)		44	52.26		11	18.49	do	Do.
Episcopal church (1865)		44	46.21		11	19.29	do	Do.
Loaf Hill		19	34.70		29	55.06	do	Do.
Lockwood		05	34.61		29	04.16	do	Do.
Lone Chimney		09	18.30		13	05.11	do	Do.
Long Neck		02	11.10		28	40.88	do	Do.
Long Neck, 2 (1882)		02	10.41		28	41.85	do	Do.
McDonald		13	08.44		09	11.26	do	Do.
Mead (1864)		18	07.34		32	53.13	do	Do.
Merwin		14	09.09		19	57.60	do	Do.
Miles Fish Works chimney		12	07.60		02	18.20	do	Do.
Milford		13	26.43		01	15.51	do	Do.
Congregational spire (1833-1884)		13	36.63		03	33.03	do	Do.
Episcopal church spire		13	27.23		03	27.73	do	Do.
Old spire with gilt ball		13	37.46		03	25.97	do	Do.
Point		10	42.67		05	51.92	do	Do.
Mill Hill		08	49.37		16	42.32	do	Do.
Mohawk		49	16.80		17	49.50	G. S.	Bull. 122.
Monroe:								
Belfry (1839)		19	55.38		12	24.48	C. & G. S.	Rept. '88.
Tall spire (1839)		19	58.84		12	26.90	do	Do.
Moose Hill, east		24	05.57		06	55.36	do	Do.
Moose Hill, Fairfield County		19	11.73		12	06.09	do	Do.
Mount Tom		41	36.43		16	25.54	do	Bull. 122.
Nash		06	04.80		25	41.60	do	Rept. '88.
Newton		25	51.86		02	04.58	do	Do.
Nichols		08	49.10		08	10.72	do	Do.
Norfield, spire (1834)		12	10.31		22	40.51	do	Do.
North Milford, spire		16	42.20		01	35.36	do	Do.
Norton		03	16.70		30	53.07	do	Do.
Norton Point		03	19.32		26	19.40	do	Do.
Norwalk, north spire (1834)		07	14.62		24	28.56	do	Do.
Norwalk Islands, light-house (1834)		02	55.43		25	10.52	do	Do.
Norwalk Islands, light-house (1882-1885).		02	55.74		25	10.53	do	Do.
Norwalk River beacon (1882)		04	23.70		24	22.10	do	Do.
Norwalk, south spire (1834)		07	07.66		24	30.78	do	Do.
Old Farms		14	53.06		09	18.82	do	Do.
Osborne		23	37.47		12	44.87	do	Do.
Palmer		03	40.87		34	06.19	do	Do.
Patrick		17	36.24		31	18.62	do	Do.
Pavement		11	37.34		17	17.35	do	Do.
Peck		22	54.11		03	30.47	do	Do.
Peet Hill		40	02.37		26	08.97	do	Do.
Penfield Reef, light-house (1882)		07	01.57		13	21.01	do	Do.
Picket Ridge		19	29.41		27	11.43	do	Do.
Pine Creek Point (1833)		07	06.34		15	42.24	do	Do.
Pine Creek Point, 3 (1882)		07	07.37		15	42.99	do	Do.
Pine Swamp Hill		21	09.10		16	29.21	do	Do.
Pond Point		12	41.24		00	38.20	do	Do.
Preston, stone church (1865)		40	37.16		22	22.82	do	Do.
Preston, white spire (1865)		41	05.78		18	42.98	do	Do.
Prospect Hill		58	45.11		23	06.28	do	Do.
Ram Island		03	32.83		24	12.52	do	Do.
Redding Ridge		18	11.10		21	12.32	do	Do.
Redding, spire (1839)		18	49.68		21	04.34	do	Do.
Ridgefield:								
Episcopal church (1865)		16	49.50		29	59.05	do	Do.
Presbyterian church (1839)		16	30.47		29	52.89	do	Do.
Riggs		24	44.15		07	48.73	do	Do.
Rock		00	06.57		37	41.22	do	Do.
Rockhouse Hill		23	04.94		08	22.13	do	Do.
Round Hill		06	13.17		40	25.79	do	Do.
Round Hill, 2 (1882)		06	13.02		40	26.23	do	Do.
Saugatuck		07	28.00		19	23.08	do	Do.
Scofield		08	20.92		34	52.98	do	Do.

CONNECTICUT—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	41°-42° ° ' "	73°-74° ° ' "		
Seaside Park, soldiers' monument....	41 09 41.58	73 11 11.92	C. & G. S.	Rept. '88.
Sheffield Island.....	02 50.20	25 21.73	do	Do.
Sheffield, west.....	02 52.01	25 27.59	do	Do.
Sherwood.....	12 09.04	13 24.07	do	Do.
Shippan.....	01 32.23	31 10.65	do	Do.
Shippan Point.....	01 12.22	31 24.38	do	Do.
Old chimney.....	01 28.00	31 12.02	do	Do.
Skagerat.....	24 46.21	03 08.84	do	Do.
Southport:				
Congregational church spire (1882).....	08 06.28	17 12.90	do	Do.
Episcopal Church spire (1882).....	08 00.25	17 16.84	do	Do.
Inner beacon (1882).....	07 33.45	17 15.45	do	Do.
Outer beacon (1882).....	07 18.86	17 15.72	do	Do.
South Whitehall.....	19 12.91	07 56.23	do	Do.
Spindle.....	00 21.54	36 44.77	do	Do.
Stamford:				
Baptist church spire (1882).....	03 18.68	32 21.29	do	Do.
Congregational church spire (1882).....	03 08.94	32 24.22	do	Do.
Harbor, light-house (1882-1885)....	00 49.21	32 34.74	do	Do.
Northeast spire (1834).....	03 14.76	32 03.19	do	Do.
Southwest spire (1834).....	03 12.78	32 21.98	do	Do.
Stanwick.....	06 33.32	36 51.06	do	Do.
Star.....	18 46.66	27 39.18	do	Do.
Stratford:				
Beacon (1881-1884).....	09 47.11	06 14.89	do	Do.
Beacon (1833).....	09 47.05	06 14.82	do	Do.
Congregational church spire (1884).....	11 33.20	07 51.82	do	Do.
Episcopal church spire (1884).....	11 18.68	07 50.06	do	Do.
Hill.....	13 08.36	09 10.79	do	Do.
Point.....	09 28.72	07 06.12	do	Do.
Point, light-house (1881-1885)....	09 07.22	06 13.47	do	Do.
Point, light-house (1833).....	09 07.24	06 13.18	do	Do.
Spire (1833).....	11 19.44	07 50.17	do	Do.
Do.....	11 32.84	07 51.56	do	Do.
St. John.....	06 58.31	25 31.86	do	Do.
Summerville.....	20 32.78	03 28.56	do	Do.
Tashua.....	15 37.84	15 01.33	do	Do.
Church (1839).....	17 13.31	15 38.87	do	Do.
Tavern Island.....	03 39.14	25 20.80	do	Do.
Flagstaff (1882).....	03 39.01	25 20.82	do	Do.
Thorp.....	07 59.10	19 09.00	do	Do.
Trumbull.....	17 46.94	15 44.52	do	Do.
Van, cupola of Shippan Point House ..	01 40.87	31 10.84	do	Do.
Wallack.....	02 11.49	30 22.80	do	Do.
Warren Observatory, flagstaff (1864) ..	43 37.45	21 13.14	do	Do.
Watchhouse on rock, west gable.....	02 23.64	29 21.98	do	Do.
Webb.....	06 53.01	34 09.84	do	Do.
Wells.....	14 18.20	07 03.23	do	Do.
West Marsh.....	04 46.56	24 36.24	do	Do.
West Rocks.....	08 06.78	24 55.06	do	Do.
Wheeler.....	15 13.48	19 41.40	do	Do.
Whitehall church (1839).....	20 02.80	08 52.37	do	Do.
Wilson Point, depot cupola.....	03 46.65	25 45.73	do	Do.
Woodbridge:				
Pointed spire.....	21 14.63	00 48.72	do	Do.
Round spire.....	21 17.81	00 46.17	do	Do.
Wooster Mountain.....	21 03.98	29 18.14	do	Bull. 122.
Great Captain Island:	40°-41° ° ' "	73°-74° ° ' "		
Light-house (1882-1885).....	40 58 57.10	73 37 26.40	do	Rept. '88.
Light-house (1834).....	58 57.18	37 26.50	do	Do.
Little Captain Island.....	59 24.93	36 31.01	do	Do.
Little Captain Island, 2 (1882).....	59 24.97	36 31.10	do	Do.
Little Captain Island, 3 (1882).....	59 19.97	36 38.95	do	Do.
Mead.....	59 52.00	39 03.26	do	Do.

NEW YORK.

	45°-46° ° ' "	74°-75° ° ' "		
Massena Point, triangulation station..	45 00 01.67	74 46 11.79	Engr. Corps..	Rept. '76.
	44°-45° ° ' "	73°-74° ° ' "		
Bald Peak.....	44 06 13.00	73 29 15.00	C. & G. S.	Do.
Barber Point, light-house.....	09 15.84	24 17.39	do	Do.
Bigelow.....	26 54.12	28 09.62	do	

NEW YORK—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	44°-45°	73°-74°		
	° ' "	° ' "		
Blueberry Hill.....	44 00 15.33	73 33 58.33	C. & G. S.	
Boquet River Point.....	21 35.67	21 20.54	do	
Catamount.....	27 34.26	52 21.76	do	
Cheever.....	04 54.05	27 02.84	do	
Clinton Mills chimney.....	57 33.74	52 58.41	G. S.	
Cherubusco.....	57 15.63	55 15.03	do	Bull. 122.
Crab Isle.....	39 54.51	25 02.09	C. & G. S.	
Crown Point light-house.....	01 47.69	25 19.24	do	
Cumberland Point.....	41 34.43	23 28.99	do	
Dannemora.....	44 30.04	42 57.60	do	Do.
Dunn.....	49 40.85	24 10.67	do	
Giant of the Valley.....	09 40.39	43 14.71	do	
Hagar.....	42 52.42	23 22.12	do	
Haseltine.....	49 38.34	55 56.95	G. S.	Do.
Hendrick.....	00 49.62	27 29.20	C. & G. S.	
Hurricane.....	14 07.23	42 38.09	do	
Ligonier Point.....	24 53.04	21 55.17	do	
Lyon, 2.....	42 16.74	51 48.74	do	Do.
Macomb.....	02 48.59	46 58.66	do	
McIntyre, summit.....	08 37.00	59 14.00	do	
Moore.....	57 53.71	51 36.52	G. S.	Do.
Mount Dix.....	04 54.51	47 12.22	C. & G. S.	
Mount Marcy.....	06 46.04	55 26.99	do	
Poke-a-moonshine.....	24 06.31	30 48.83	do	
Rams Head.....	46 45.26	22 50.78	do	
Rand.....	45 28.87	36 43.99	do	
Selden.....	19 30.98	21 08.48	do	
Split Rock Point.....	15 54.96	19 44.31	do	
Trembleau Point.....	31 04.44	23 09.82	do	
West Hill.....	51 18.11	58 31.08	G. S.	Do.
Whiteface.....	21 56.99	54 12.77	C. & G. S.	
	44°-45°	75°-76°		
Alexandria.....	44 19 38.90	75 55 23.40	L. S.	Final Rept.
Thousand Island House.....	20 15.20	55 16.40	do	Do.
Boundary post No. 2, Franklin County.....	59 58.20	39 32.20	do	Do.
Brook Point.....	36 54.40	36 38.00	do	Do.
Buckminster.....	01 32.44	59 25.80	G. S.	Bull. 122.
Chapman.....	33 32.60	41 46.90	L. S.	Final Rept.
Chimney Point.....	43 55.70	26 56.40	do	Do.
Crossover Island light-house.....	29 48.60	46 44.10	do	Do.
Dingham.....	21 19.00	53 04.50	do	Do.
Hall Dock.....	32 46.70	42 45.90	do	Do.
Lyons.....	25 01.50	49 00.70	do	Do.
Miller.....	14 21.87	45 22.13	G. S.	Bull. 122.
Morristown Point.....	35 55.50	38 33.50	L. S.	Final Rept.
Oak Point.....	30 56.90	45 13.10	do	Do.
Ogdensburg:				
East base.....	42 29.60	27 56.30	do	Do.
West base.....	42 19.00	28 48.50	do	Do.
Light-house, or A.....	41 52.30	30 14.50	do	Do.
Light-house, peak of.....	41 52.30	30 14.00	do	Do.
Peach Island.....	29 27.80	46 07.90	do	Do.
Sharp.....	49 07.00	17 40.80	do	Do.
Sister Island, light-house.....	24 50.80	50 41.90	do	Do.
Sparrowhawk.....	48 02.80	20 43.30	do	Do.
Sunken Rock, light-house.....	20 44.60	54 57.40	do	Do.
Taylor.....	33 05.20	42 23.70	do	Do.
Wagner.....	46 25.00	21 43.20	do	Do.
	44°-45°	76°-77°		
Cape Vincent.....	44 07 31.40	76 20 32.10	do	Do.
East base.....	07 41.60	17 34.70	do	Do.
West base.....	07 54.00	18 55.30	do	Do.
Carlton.....	10 58.97	17 38.75	do	Do.
Clayton:				
Roman Catholic church.....	14 18.80	05 12.20	do	Do.
South base, Jefferson County.....	14 04.10	04 34.10	do	Do.
Daly.....	10 03.60	18 35.10	do	Do.
Dorr farm.....	14 37.90	03 21.70	do	Do.
Ellis.....	08 34.20	17 44.00	do	Do.
Grenadier.....	02 11.71	22 32.40	do	Do.
Grindstone.....	16 04.00	08 57.80	do	Do.
Hogsback.....	12 02.20	09 08.10	do	Do.
Pamelia.....	05 24.76	52 34.78	G. S.	Bull. 122.
Rock Island light-house.....	16 49.00	01 02.00	L. S.	Final Rept.
Seeber.....	06 28.26	00 54.81	G. S.	Bull. 122.
Tibbett Point, light-house.....	06 02.30	22 15.40	L. S.	Final Rept.
Wolfe.....	07 31.12	23 19.98	do	Do.
	43°-44°	73°-74°		
Ambler.....	43 05 36.56	73 51 08.73	S. S.	Rept. '87,
Austin.....	35 03.78	24 34.98	C. & G. S.	

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	43°-44°			73°-74°				
	°	'	"	°	'	"		
Bailey	43	04	09.77	73	39	17.54	S. S.	Rept. '87.
Ballston		00	48.00		51	03.00	do	Rept. '83.
Barber		34	46.32		26	02.68	C. & G. S.	
Birch		20	18.94		20	11.01	G. S.	Bull. 122.
Black Mountain		36	24.30		31	53.90	C. & G. S.	
Breed Hill		55	19.37		25	43.27	do	
Brimstone		44	45.28		25	00.49	do	
Crain		32	41.83		57	46.36	do	
Crown Point, south base		58	51.07		25	29.44	do	
Felton Hill		01	05.64		28	10.40	G. S.	Do.
Greenwich		07	35.12		31	30.61	C. & G. S.	Do.
Jackson		04	41.28		23	59.08	G. S.	Do.
Londonville, home lawn flag pole		43	42.91		45	35.78	S. S.	Rept. '87.
Mount Tom		41	47.26		24	41.28	C. & G. S.	
Prospect		25	17.95		46	04.57	do	Rept. '85.
Rascal		15	39.49		24	15.68	G. S.	Bull. 122.
Saratoga		04	07.40		47	22.92	S. S.	Rept. '87.
Saratoga Springs:								
Methodist Episcopal church spire		04	49.53		47	16.08	do	Do.
Presbyterian church spire		05	02.55		47	03.99	do	Do.
Catholic church spire		04	35.62		47	14.46	do	Do.
Skeenes		33	26.03		23	48.28	C. & G. S.	
Snody		36	50.25		23	26.75	do	
	43°-44°			74°-75°				
	°	'	"	°	'	"		
Bart Hill	43	07	50.07	74	53	24.38	S. S.	
Barto		07	50.07		53	24.37	do	Rept. '87.
Broadalbin:								
Baptist church cupola		03	28.94		11	55.19	do	Do.
Methodist Episcopal church, tower		03	27.11		11	59.81	do	Do.
Clip Hill		03	04.06		25	29.90	do	Do.
County line, stone No. 88, between Fulton and Montgomery counties		01	09.00		39	42.00	do	Rept. '83.
Fairfield:								
Academy		08	18.12		54	47.24	do	Rept. '87.
Methodist Episcopal church		08	13.52		54	51.99	do	Do.
Presbyterian church or town hall		08	18.74		54	59.60	do	Do.
Protestant Episcopal church		08	09.20		54	40.43	do	Do.
Galway		04	05.30		02	35.49	do	Do.
Gloversville:								
Baptist church spire		02	56.16		20	49.46	do	Do.
Collins Bros.' building, flag pole		03	04.90		20	44.19	do	Do.
Congregational church, white spire		03	03.19		20	39.82	do	Do.
First Methodist Episcopal church spire		03	06.88		20	48.14	do	Do.
First Presbyterian church spire		03	02.34		20	48.38	do	Do.
Gore		40	15.10		02	58.49	C. & G. S.	
Hamilton		24	41.82		22	00.15	do	
Herkimer		01	37.10		56	55.24	S. S.	Do.
Court-house		01	44.56		59	21.96	do	Do.
Dutch Reformed church		01	44.55		59	24.56	do	Do.
Methodist Episcopal church		01	32.49		59	20.53	do	Do.
Schoolhouse		01	41.17		59	13.32	do	Do.
Johnstown:								
Court-house dome		00	24.01		22	30.02	do	Do.
Fire department house pinnacle		00	18.77		22	29.15	do	Do.
First Baptist church spire		00	22.23		22	32.03	do	Do.
Martin Kennedy's house pinnacle		00	10.32		22	28.60	do	Do.
Presbyterian church spire		00	16.50		22	23.65	do	Do.
St. Patrick's Roman Catholic church spire		00	15.50		22	09.48	do	Do.
St. Paul's Lutheran church spire		00	28.56		22	17.33	do	Do.
Sir W. Johnson hotel flag pole		00	24.97		22	29.41	do	Do.
United Presbyterian church spire		00	26.71		22	24.17	do	Do.
Kingsboro		05	05.53		21	28.15	do	Do.
Presbyterian church tower		04	01.70		20	13.46	do	Do.
Schoolhouse cupola		03	57.22		20	12.78	do	Do.
Little Falls		02	59.51		51	38.18	do	Do.
Baptist church		02	35.75		51	26.27	do	Do.
Methodist Episcopal church		02	34.66		51	28.87	do	Do.
Presbyterian church		02	43.17		51	32.62	do	Do.
Roman Catholic church (new), Church of the Assumption		02	37.73		51	12.15	do	Do.
Roman Catholic church (old)		02	41.45		51	08.19	do	Do.
Mayfield:								
Methodist church tower (white)		06	19.48		15	50.78	do	Do.
Presbyterian church, white, four-pinnacled tower		06	19.80		15	48.70	do	Do.
Middle Sprite, Free Methodist church		07	15.82		38	20.78	do	Do.
North Galway, Christian church		03	57.19		03	15.13	do	Do.

NEW YORK—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	43°-44° ° ' "	74°-75° ° ' "		
Oppenheim, Methodist Episcopal church.	43 04 23.17	74 41 36.38	S. S.	Rept. '87
Perth Center, United Presbyterian church tower.	01 08.04	11 26.69	do	Do.
Royal Hill	05 08.67	31 07.95	do	Do.
St. Johnsville	00 24.92	40 12.25	do	Do.
Grace Protestant Episcopal church cross.	00 01.57	40 46.08	do	Do.
Schoolhouse cupola	00 03.23	40 35.36	do	Do.
Snowy Mountain	41 55.53	23 13.45	C. & G. S.	
Speculator	27 36.03	20 24.94	do	
Twin:				
Methodist Episcopal church	02 21.23	42 52.95	S. S.	Do.
Union church	02 22.56	42 53.42	do	Do.
Van der Whacken	53 53.74	05 46.96	C. & G. S.	
Vedder	01 07.65	39 02.59	S. S.	Do.
West Galway:				
Methodist Episcopal church	00 23.24	06 08.42	do	Do.
Presbyterian church	00 20.20	06 07.96	do	Do.
North Presbyterian church tower	00 22.00	06 09.00	do	Do.
Scotch Presbyterian church	00 14.09	06 09.45	do	Do.
West Perth	00 30.60	16 18.44	do	Do.
	43°-44° ° ' "	75°-76° ° ' "		
Allis	43 05 18.17	75 48 06.64	do	Do.
Amboy	23 14.20	55 07.54	do	Do.
Boynton	53 52.46	55 41.02	C. & G. S.	Bull. 122.
Bridgeport, Methodist Episcopal church.	09 23.09	58 12.44	S. S.	Rept. '87.
Bulger	03 55.89	39 59.75	do	Do.
Canastota	04 20.64	44 20.44	do	Do.
Baptist church	04 28.62	45 08.22	do	Do.
Free church	04 41.71	45 11.20	do	Do.
Methodist Episcopal church	04 51.81	45 19.90	do	Do.
Carl	51 37.67	46 56.10	C. & G. S.	Bull. 122.
Chittenango Station, Free Methodist church.	05 15.34	52 22.93	S. S.	Rept. '87.
Churchville:				
German Lutheran church (east) ..	11 30.42	34 16.77	do	Do.
German Lutheran church (west) ..	11 27.19	34 21.61	do	Do.
Seven-Day Baptist church	11 21.95	34 32.10	do	Do.
Cleveland, Protestant Episcopal church.	14 02.25	52 54.64	do	Do.
Clinton	03 17.00	01 37.44	do	Do.
Cranson	01 04.01	46 02.07	do	Do.
Deerfield Corners:				
Baptist church	06 51.15	12 08.17	do	Do.
St. Peter's church, Roman Catholic	06 58.93	12 37.54	do	Do.
Devereux	04 46.71	14 54.11	do	Do.
Durhamville:				
Baptist church	07 05.65	40 10.10	do	Do.
German Catholic church	07 09.58	40 07.96	do	Do.
Eagle	01 25.86	55 10.83	do	Do.
Eaton	01 43.99	33 19.38	do	Do.
Fish Creek, Union church	13 12.59	41 56.49	do	Do.
Florence C. S.	23 14.49	39 36.30	do	Do.
Floyd Corners	13 09.86	20 06.10	do	Do.
Greene	51 22.53	48 53.76	C. & G. S.	Bull. 122.
Hamilton College, chapel dome ..	03 07.13	24 21.29	S. S.	Rept. '87.
Higginsville, Presbyterian church	10 34.71	38 40.62	do	Do.
Ilion	00 36.00	01 52.39	do	Do.
Presbyterian church	00 48.03	02 20.34	do	Do.
St. Mary's church, Roman Catholic	00 41.58	01 45.18	do	Do.
Johnson	57 16.05	50 33.36	C. & G. S.	Bull. 122.
Jackson	05 54.86	01 41.39	S. S.	Do.
Kirkville	04 19.54	56 16.23	do	Rept. '87.
Methodist Episcopal church	04 31.00	57 04.85	do	Do.
Lowrey	41 47.37	59 55.94	C. & G. S.	Bull. 122.
Manlius Station, Methodist Episcopal church.	04 41.94	59 55.74	S. S.	Rept. '87.
Merry	02 51.54	10 24.00	do	Do.
Mohawk:				
Dutch Reformed church	00 36.42	00 19.83	do	Do.
Methodist Episcopal church	00 43.31	00 10.12	do	Do.
Universalist church	00 39.79	00 29.48	do	Do.
New York Mills Methodist Episcopal church.	06 13.01	17 36.79	do	Do.
North Gage, Union church	13 23.17	07 12.32	do	Do.
North Manlius P. O.:				
Baptist church	05 57.91	58 22.11	do	Do.
Methodist Episcopal church	06 01.22	58 20.75	do	Do.

NEW YORK—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	43°-44°	75°-76°		
Oneida:	° ' "	° ' "		
Baptist church.....	43 05 37.29	75 39 06.25	S. S.....	Rept. '87.
Opera-house dome.....	05 44.29	39 10.45	do.....	Do.
Presbyterian church.....	05 38.45	39 06.91	do.....	Do.
Castle Presbyterian church.....	04 46.07	38 06.51	do.....	Do.
Perryville, Protestant Episcopal church.....	00 24.81	47 57.27	do.....	Do.
Prospect.....	02 15.39	26 40.36	do.....	Do.
Quality Hill, Presbyterian church.....	04 03.39	46 33.31	do.....	Do.
Ridgeville, Presbyterian church.....	07 57.27	47 28.96	do.....	Do.
Rome.....	14 03.00	27 58.13	do.....	Do.
Baptist church.....	12 58.74	27 33.25	do.....	Do.
First Methodist Episcopal church.....	12 59.08	27 30.77	do.....	Do.
German Catholic church.....	12 48.27	27 33.95	do.....	Do.
Presbyterian church.....	12 49.47	27 23.37	do.....	Do.
St. Joseph's church (Roman Catholic).....	12 28.22	27 44.19	do.....	Do.
Welsh Presbyterian church.....	12 52.61	27 33.22	do.....	Do.
Russia Union church.....	15 28.76	04 47.63	do.....	Do.
Schuyler.....	09 43.94	06 59.12	do.....	Do.
Starr.....	20 42.20	14 59.31	do.....	Rept. '87.
Thomas.....	34 36.42	58 54.09	C. & G. S.....	Bull. 122.
Tyler, Wesleyan Methodist church.....	05 40.74	54 50.04	S. S.....	Rept. '87.
Utica:				
City hall, flag pole.....	06 03.47	13 58.48	do.....	Do.
First Methodist Episcopal church.....	06 01.09	14 08.94	do.....	Do.
First Dutch Reformed church.....	05 55.60	14 14.59	do.....	Do.
First Presbyterian church.....	06 07.33	13 58.95	do.....	Do.
Grace Protestant Episcopal church.....	06 04.41	13 53.36	do.....	Do.
St. Patrick's church (Roman Catholic).....	06 15.36	14 28.33	do.....	Do.
Trinity Protestant Episcopal church.....	06 09.26	13 25.04	do.....	Do.
Westminster church.....	06 02.18	14 03.28	do.....	Do.
Vernon:				
Baptist church.....	04 47.02	32 31.39	do.....	Do.
Methodist Episcopal church.....	04 43.39	32 29.00	do.....	Do.
Presbyterian church.....	04 39.73	32 35.09	do.....	Do.
Unitarian church.....	04 45.41	32 28.80	do.....	Do.
Vernon Center:				
Methodist Episcopal church.....	03 11.21	30 08.94	do.....	Do.
Presbyterian church.....	03 11.20	30 05.91	do.....	Do.
Verona:				
Methodist Episcopal church.....	08 13.82	34 18.43	do.....	Do.
Presbyterian church.....	08 18.71	34 15.85	do.....	Do.
Vienna.....	14 49.63	40 47.47	do.....	Do.
Methodist Episcopal church.....	14 21.43	42 10.08	do.....	Do.
Watertown, court-house, northeast corner of cupola.....	58 32.88	55 01.95	L. S.....	Final Rept.
Wampsville, Presbyterian church.....	04 29.99	42 20.98	S. S.....	Rept. '87
Westmoreland, Presbyterian church.....	06 56.61	24 21.34	do.....	Do.
West Schuyler, Methodist Episcopal church.....	05 55.73	09 09.96	do.....	Do.
Whitesboro, Baptist church.....	07 23.86	17 34.03	do.....	Do.
Williams.....	10 15.13	13 20.90	do.....	Do.
	43°-44°	76°-77°		
Amboy, Presbyterian church spire.....	43 04 14.00	76 16 19.00	do.....	Rept. '83.
Big Sodus, light-house, Wayne County.....	16 25.70	59 11.80	L. S.....	Final Rept.
Brayton barn, cupola, west wing.....	04 14.33	04 47.09	S. S.....	Rept. '87
Brewerton, west spire of Disciples church.....	14 16.21	08 26.26	do.....	Do.
Carpenter.....	00 33.93	17 05.36	do.....	Do.
Cassett.....	00 02.19	11 35.09	do.....	Do.
Central Square, church spire.....	17 13.50	08 45.88	do.....	Do.
Chestnut Ridge.....	05 48.66	11 14.77	do.....	Do.
Clyde, L. S.....	03 05.07	51 49.34	do.....	Do.
Collamer.....	06 04.87	03 28.77	do.....	Do.
Methodist Episcopal church.....	06 15.13	03 53.64	do.....	Do.
Colwell.....	41 40.56	11 10.78	G. S.....	Bull. 122.
Constantia, Presbyterian church.....	14 55.00	00 11.00	S. S.....	Rept. '83.
Cooper.....	57 48.20	16 41.50	L. S.....	Bull. 122.
Davison.....	06 07.41	17 04.12	S. S.....	Rept. '87.
Deuel.....	54 23.90	12 29.30	do.....	Do.
Draper.....	03 02.67	12 10.75	do.....	Do.
Dyke.....	31 39.54	14 24.76	G. S.....	Bull. 122.
Fairmount.....	02 36.75	15 22.68	S. S.....	Rept. '87.
Fayetteville:				
Presbyterian church.....	01 45.50	00 27.09	do.....	Do.
Protestant Episcopal church.....	01 45.76	00 25.23	do.....	Do.
Roman Catholic church.....	01 47.21	00 16.20	do.....	Do.

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	43°-44°			76°-77°				
	°	'	"	°	'	"		
Fox.....	43	58	05.60	76	12	04.20	L. S.	Rept. '87.
Fulton, Falley Academy.....		19	17.00		24	43.00	S. S.	Rept. '83.
Galloo.....		55	07.60		24	36.10	L. S.	Final Rept.
Light-house.....		53	18.60		26	41.90	do	Do.
Gasport.....		11	56.77		32	31.90	do	Do.
Geddes, Methodist Episcopal church.....		03	07.17		11	23.97	S. S.	Rept. '87.
Gilbertsville.....		18	42.32		17	49.66	do	Do.
Gleason.....		52	48.90		15	32.80	L. S.	Bull. 122.
Greene.....		31	30.80		22	24.20	do	Do.
Houston.....		31	30.30		15	19.20	do	Do.
Hovey.....		53	04.77		14	09.99	G. S.	Do.
Kingsley.....		07	12.90		18	00.25	S. S.	Rept. '87.
Liverpool, Methodist Episcopal church spire.....		06	13.72		12	24.86	do	Do.
Loomis.....		21	18.46		17	10.37	C. & G. S.	Bull. 122.
Mannsville.....		42	54.41		03	14.61	L. S.	Do.
Munn Davis.....		09	47.34		18	44.36	S. S.	Rept. '87.
North base, between Jefferson and Oswego counties.....		40	43.61		12	02.03	L. S.	Do.
Northup.....		00	03.70		21	25.39	S. S.	Do.
Olympus.....		02	04.24		07	55.56	do	Do.
Onondaga Hill, Presbyterian church.....		00	12.53		11	00.98	do	Do.
Oswego.....		26	37.28		30	50.41	L. S.	Final Rept.
Do.....		26	39.57		30	53.55	do	Do.
Court-house.....		27	26.00		30	22.80	do	Do.
Light-house.....		27	53.90		30	50.90	do	Do.
Sacketts Harbor, or Horse Island, light-house.....		56	34.70		08	43.00	do	Do.
Sandy Creek.....		39	06.93		06	08.40	do	Bull. 122.
Sherwood.....		02	13.45		17	17.22	S. S.	Rept. '87.
Silver Star, St. Mary's church.....		05	15.29		00	08.33	do	Do.
Sorrel Hill.....		06	51.54		21	23.62	do	Do.
South base.....		38	05.19		11	51.52	L. S.	Do.
Stony Point.....		50	47.56		17	28.19	do	Final Rept.
Light-house.....		50	21.60		17	56.80	do	Do.
Syracuse:								
First Presbyterian church spire.....		02	54.73		09	08.26	S. S.	Rept. '87.
St. John's Roman Catholic church spire.....		04	06.74		09	28.81	do	Do.
St. Lucy's Roman Catholic church spire.....		02	36.27		09	45.39	do	Do.
Tanner.....		01	14.82		33	29.82	do	Do.
Victory L. S.....		13	06.82		36	22.13	do	Do.
	43°-44°			77°-78°				
	°	'	"	°	'	"		
Brockport.....	43	11	28.81	77	56	03.68	L. S.	Final Rept.
Baptist church.....		12	49.70		56	23.50	do	Do.
Corner of lots 5, 8, 11, 14.....		11	54.00		56	39.30	do	Do.
Genesee, light-house.....		15	09.80		36	40.20	do	Do.
Palmyra L. S.....		04	03.76		09	37.78	S. S.	Rept. '87
Pinnacle Hill.....		08	06.47		35	10.67	L. S.	Do.
Rochester:								
City Hall statue.....		09	22.44		36	51.00	do	Final Rept.
Court-house.....		09	18.10		36	50.70	do	Do.
Tower of waterworks.....		12	45.80		37	36.70	do	Do.
Sodus.....		14	13.74		04	44.74	do	Do.
Dome of Academy.....		14	08.50		04	09.30	do	Do.
Turk Hill.....		02	10.44		25	23.26	S. S.	Rept. '87.
Walworth.....		09	22.43		20	01.25	L. S.	Final Rept.
Alabama Center:								
Baptist church spire.....	43	05	42.49	78	23	22.08	S. S.	Rept. '87.
Methodist Episcopal church spire.....		05	45.49		23	19.90	do	Do.
Albion.....		14	22.65		09	19.67	L. S.	Final Rept.
Albion Cemetery, soldier's head on monument.....		11	22.75		19	29.76	S. S.	Rept. '87.
Barre Center, Presbyterian church.....		11	06.80		11	41.24	do	Do.
Batavia.....		01	18.05		15	45.63	do	Do.
Blind Institute, flag pole.....		00	21.51		11	05.99	do	Do.
Bumpus.....		05	48.63		17	34.41	do	Do.
Dillingham's house, center.....		05	47.67		17	35.01	do	Do.
East Shelby.....		10	03.45		19	58.83	do	Do.
Advent church spire.....		10	10.87		19	31.20	do	Do.
Methodist Episcopal church spire.....		09	23.65		19	32.30	do	Do.
Edwards.....		08	54.61		22	03.90	do	Do.
Elba.....		05	32.26		08	42.99	do	Do.
Methodist Episcopal church spire.....		04	51.46		11	06.94	do	Do.
Presbyterian church spire.....		04	58.19		11	11.96	do	Do.
Schoolhouse cupola, district No. 2.....		05	28.46		09	23.91	do	Do.
Falkirk.....		01	22.85		28	58.22	L. S.	Final Rept.
Genung.....		09	42.98		10	33.96	S. S.	Rept. '87.

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	43°-44°			78°-79°				
	°	'	"	°	'	"		
Kimpton's (S.) barn, west cupola.....	43	09	30.33	78	11	11.85	S. S.....	Rept. '87.
Macomber, 302.....		04	39.34		18	39.60	do.....	Do.
Macomber's, J. S., house tower.....		04	38.52		18	41.29	do.....	Do.
Monument 300.....		11	09.46		11	40.14	do.....	Do.
Monument 363.....		09	50.54		19	31.47	do.....	Do.
Monument 367.....		04	57.51		11	12.17	do.....	Do.
Morganville (L. S.).....		00	40.11		02	58.60	do.....	Do.
Christian church tower.....		00	13.44		04	35.40	do.....	Do.
Oakfield.....		04	05.72		16	25.68	do.....	Do.
Methodist Episcopal church tower.....		04	01.90		16	24.05	do.....	Do.
Presbyterian church tower.....		04	06.14		16	24.76	do.....	Do.
Seminary tower.....		03	55.90		16	09.92	do.....	Do.
Parker.....		06	56.40		09	50.49	do.....	Do.
Pekin.....		10	14.70		52	31.28	L. S.....	Final Rept.
Pond.....		03	35.94		19	38.56	S. S.....	Rept. '87.
Pumpkin Hill, Baptist church.....		05	51.89		04	01.41	do.....	Do.
Pusel.....		09	56.73		15	47.60	do.....	Do.
Quaker church, east gable.....		06	01.20		11	37.72	do.....	Do.
Ross.....		10	43.20		21	29.95	do.....	Do.
Ryan.....		10	25.76		24	37.39	do.....	Do.
South Alabama, Baptist church spire.....		04	23.46		20	07.61	do.....	Do.
Tall Tree.....		10	12.80		23	35.66	do.....	Do.
Thirty-mile Point, light.....		22	29.60		29	11.80	L. S.....	Final Rept.
Tonawanda.....		00	03.84		53	21.91	do.....	Bull. 122.
Vulgary.....		06	54.09		12	12.11	S. S.....	Rept. '87.
Watson's (David) barn, west gable.....		06	44.77		07	57.59	do.....	Do.
West Barre, Methodist Episcopal church cupola.....		09	07.13		15	11.47	do.....	Do.
West Shelby, Methodist Episcopal church spire.....		09	39.26		26	12.95	do.....	Do.
Yates, spire of church.....		20	15.80		23	17.50	L. S.....	Final Re
	43°-44°			79°-80°				
Fort Niagara, light-house.....	43	15	42.30	79	03	40.00	do.....	Do.
Niagara Falls, northeast tower of railroad suspension bridge.....		06	34.10		03	26.30	do.....	Do.
	42°-43°			73°-74°				
Abutment.....	42	39	15.26	73	44	39.80	S. S.....	Rept. '87.
Academy Hill.....		14	37.87		46	36.24	do.....	Do.
Adams.....		59	52.82		21	04.00	C. & G. S.....	Bull. 122.
Adamsville, Methodist Episcopal church.....		37	21.66		50	11.36	S. S.....	Rept. '87.
Albany:								
Academy of the Sacred Heart.....		37	40.18		40	21.06	do.....	Do.
Congregational Church spire.....		38	57.98		45	26.92	do.....	Do.
Cathedral spire.....		38	51.31		45	35.55	do.....	Do.
Dudley Observatory, center of equatorial dome.....		39	51.81		45	01.47	do.....	Do.
First Lutheran church.....		39	06.88		45	13.25	do.....	Do.
Fourth Presbyterian church spire.....		39	20.23		44	57.86	do.....	Do.
German Roman Catholic church, Our Lady of the Angel.....		39	43.30		46	10.07	do.....	Do.
Sacred Heart Roman Catholic church, North Albany.....		40	20.03		44	23.22	do.....	Do.
St. Patrick's Roman Catholic church spire.....		39	50.25		46	17.96	do.....	Do.
St. Paul's German Evangelical Lutheran church spire.....		39	32.36		46	08.89	do.....	Do.
St. Peter's Protestant Episcopal church spire.....		39	02.88		45	15.91	do.....	Do.
Second Presbyterian church spire.....		39	04.44		45	12.24	do.....	Do.
State Hall, flag pole.....		39	07.00		45	17.00	do.....	Rept. '83.
State Street Presbyterian church spire.....		39	13.70		45	41.16	do.....	Rept. '87.
Tabernacle Baptist church spire.....		39	19.05		45	06.73	do.....	Do.
Trinity Methodist Episcopal church.....		39	18.05		45	56.79	do.....	Do.
Waterworks chimney.....		40	22.00		46	42.00	do.....	Rept. '83.
Waterworks gatehouse pole.....		40	23.00		46	49.00	do.....	Do.
Alvord.....		19	10.52		46	29.39	do.....	Rept. '87.
Arsenal.....		43	11.01		42	06.58	do.....	Do.
Athens:								
Knickerbocker Ice Company's chimney.....		15	55.10		48	18.18	do.....	Do.
Protestant Episcopal church.....		15	53.99		48	27.82	do.....	Do.
Reformed church.....		15	48.08		48	42.28	do.....	Do.
Schoolhouse cupola, District No. 1.....		16	15.51		48	16.78	do.....	Do.
Barren Island.....		27	51.78		47	09.03	do.....	Do.
Flag pole.....		28	05.45		47	11.84	do.....	Do.
Bailey.....		24	04.19		46	44.47	do.....	Do.
Baker.....		31	48.13		46	00.86	do.....	Do.

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			73°-74°				
	°	'	"	°	'	"		
Ball grounds.....	42	38	38.06	73	44	45.52	S. S.	Rept. '87.
Bath.....		39	35.30		43	53.63	do	Do.
Becker.....		59	58.51		31	40.60	C. & G. S.	Bull. 122
Bell.....		27	44.40		46	04.52	S. S.	Rept. '87.
Belvidere Hotel, flag pole.....		35	54.80		44	18.34	do	Do.
Best.....		22	21.63		47	06.24	do	Do.
Bethlehem.....		34	45.94		47	52.86	do	Do.
Dutch Reformed church, north of Becker Corner.		33	43.29		48	19.78	do	Do.
Black Rock.....		15	23.22		48	51.39	do	Do.
Blodget.....		30	56.93		53	44.91	do	Do.
Blue Hill.....		11	05.64		48	55.51	C. & G. S.	
Bluff.....		26	53.12		46	18.60	S. S.	Do.
Bogardus.....		22	08.70		47	56.94	do	Do.
House, east gable.....		22	11.47		47	58.41	do	Do.
Boulder.....		17	16.86		46	31.75	do	Do.
Bronk.....		25	37.90		47	25.92	do	Do.
Barn cupola.....		25	32.73		47	17.79	do	Rept. '87.
Island.....		24	16.49		47	12.08	do	Do.
Burhans.....		00	29.27		57	13.95	C. & G. S.	Do.
Burnt Hills.....		54	35.82		54	16.45	S. S.	Do.
Christian church.....		54	35.64		53	31.54	do	Do.
Baptist church.....		54	25.59		53	47.60	do	Do.
Campbell.....		42	10.86		44	21.89	do	Do.
Island.....		33	17.93		45	05.28	do	Do.
Cass.....		34	12.65		59	15.72	do	Do.
Castleton.....		32	11.22		45	14.92	do	Do.
Dutch Reformed church.....		31	58.00		45	21.41	do	Do.
Cedar Hill.....		32	57.83		45	33.29	do	Do.
Center street.....		44	34.55		41	26.66	do	Do.
Church's (F. E.) house tower.....		13	01.37		49	46.74	do	Do.
Clapper.....		30	59.83		45	43.01	do	Do.
Clarksville.....		34	32.83		57	38.30	do	Do.
Dutch Reformed church spire.....		34	32.00		57	40.00	do	Rept. '83.
Clow, barn flag pole.....		18	14.98		47	40.20	do	Rept. '87.
Coeymans:								
Academy.....		28	23.40		47	55.24	do	Do.
Cemetery, Briggs monument.....		28	01.78		47	42.39	do	Do.
Dike light-house.....		28	30.93		47	04.17	do	Do.
Dock flag pole.....		28	23.00		47	24.00	do	Rept. '83.
Cohoes, Roman Catholic church.....		46	27.15		41	57.95	do	Rept. '87.
Colvin.....		24	39.88		47	28.40	do	Do.
Cooper Creek.....		35	10.87		45	13.76	do	Do.
Corning.....		36	54.35		46	15.03	do	Do.
Countryman.....		37	02.04		59	20.68	do	Do.
County line monument.....		46	33.00		47	59.00	do	Rept. '83.
Cow Island, light-house.....		32	16.18		45	20.78	do	Rept. '87.
Coxsackie.....		21	10.27		47	44.97	do	Do.
K. I. Co.'s flag pole.....		20	48.55		47	30.42	do	Do.
Light-house.....		22	47.18		47	42.78	do	Do.
Methodist Episcopal church tower.....		20	58.52		47	53.64	do	Do.
Noble's brickyard chimney.....		21	42.02		48	12.84	do	Do.
Protestant Episcopal church.....		21	11.10		48	13.18	do	Do.
Roman Catholic church, cross.....		20	57.97		47	45.52	do	Do.
Railroad station chimney.....		21	15.50		47	00.79	do	Do.
Reformed church.....		20	54.78		47	51.29	do	Do.
Upper Village Reformed church.....		21	43.17		49	18.51	do	Do.
Island.....		22	00.92		47	39.04	do	Do.
Denison.....		36	50.21		45	21.68	do	Do.
Dominie's Hook (bolt).....		35	42.63		45	50.65	do	Do.
Dubois.....		16	25.71		46	49.53	do	Do.
Dunnsville, Methodist Episcopal church spire.....		44	34.00		58	55.00	do	Rept. '83.
Dutch Reformed church, 1 mile north of Becker Corner.....		38	42.00		48	20.00	do	Do.
East Albany, St. John's Roman Catho- lic church.....		38	26.12		44	20.90	do	Rept. '87.
East Greenbush:								
Dutch Reformed church.....		35	18.42		42	00.69	do	Do.
Methodist Episcopal church.....		35	16.17		41	57.35	do	Do.
Ferris.....		40	35.51		45	13.30	do	Do.
Feura Bush, Dutch Reformed church spire.....		34	35.00		52	53.00	do	Rept. '83.
Five Hook Island, light-house.....		27	48.75		46	55.24	do	Rept. '87.
Forbes.....		40	07.68		43	12.61	do	Do.
Fordham Point.....		20	40.13		46	52.15	do	Do.
Four Mile Point.....		18	21.96		47	01.83	do	Do.
Light-house.....		18	21.91		47	01.49	do	Do.
Freight yard.....		16	36.77		47	51.94	do	Do.
Freleigh.....		46	35.27		47	12.17	do	Do.
Grandview.....		35	55.66		43	56.92	do	Do.

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			73°-74°				
	°	'	"	°	'	"		
Greenbush:								
Presbyterian church	42	38	10.70	73	44	56.76	S. S.	Rept. '87.
Ferry		38	30.21		45	03.56	do	Do.
Greenport, Reformed church		11	56.18		48	12.89	do	Do.
Guilderland		42	02.29		58	01.51	do	Do.
Church spire		42	14.00		58	10.00	do	Rept. '83.
Lutheran church spire		42	15.24		58	09.74	do	Rept. '87.
Hallenbeck		35	56.18		40	08.38	C. & G. S.	Do.
South		16	19.20		49	58.70	S. S.	Do.
Hamiltonville:								
Methodist Episcopal church spire		42	16.00		54	43.00	do	Rept. '83.
Three point (no station mark)		42	29.17		55	12.76	do	Rept. '87.
Hotailing Island		26	55.95		46	55.92	do	Do.
Home Lawn flag pole		43	41.00		45	36.00	do	Rept. '83.
Hudson (bolt)		15	22.54		47	51.34	do	Rept. '87.
Baptist church		15	05.93		47	27.95	do	Do.
Light-house		15	07.29		48	33.01	do	Do.
Lutheran church		14	55.30		47	03.34	do	Do.
Presbyterian church		15	04.27		47	21.98	do	Do.
Protestant Episcopal church		15	00.24		47	22.53	do	Do.
Roman Catholic church		15	05.09		47	38.86	do	Do.
Universalist church		15	00.31		47	14.32	do	Do.
Waterworks chimney		15	19.54		47	54.66	do	Do.
Iron works		42	23.39		41	47.03	do	Do.
Judson		19	47.63		46	03.76	do	Do.
Judson, barn cupola		19	44.00		46	01.00	do	Rept. '83.
Junction		19	48.24		46	26.15	do	Rept. '87.
Kinderhook, Reformed church		23	36.71		42	04.58	do	Do.
Knickerbocker, house cupola		27	40.55		46	11.99	do	Do.
Lampman		20	28.32		47	43.68	do	Do.
Lansing		44	12.82		42	58.58	do	Do.
Lansing Pine		45	38.73		50	37.75	do	Do.
Lisha's Kill, Dutch Reformed church		45	21.91		52	35.76	do	Do.
Lower Schodack Island		27	42.16		46	33.69	do	Do.
Merino, Columbia County		14	05.06		49	03.54	do	Bull. 122.
Merwin		21	23.61		41	23.01	do	Do.
Milham (Levi), house cupola		23	49.92		43	26.08	do	Rept. '87.
Moles		37	43.18		45	02.77	do	Do.
Monument 20		45	26.61		57	49.07	do	Do.
Monument 97		46	28.07		49	24.17	do	Do.
Monument 192		40	47.28		43	23.57	do	Do.
Morrison		15	14.35		49	39.93	do	Do.
Mount Merino		14	05.06		49	03.53	do	Do.
Mount Olympus		44	40.24		41	01.67	do	Do.
Mull		29	55.00		47	04.07	do	Do.
Mull Island		28	26.46		47	04.62	do	Do.
Mull Plaat		29	18.09		47	00.39	do	Do.
Muller		34	16.31		44	59.99	do	Do.
New Baltimore:								
Baptist church		26	46.49		47	24.54	do	Do.
Dike light-house		27	08.99		46	34.80	do	Do.
Dutch Reformed church		26	44.71		47	20.78	do	Do.
Light-house		27	04.42		47	02.69	do	Do.
Methodist Episcopal church		26	53.94		47	17.69	do	Do.
Riverside House, summer-house flag pole.		26	44.09		47	13.22	do	Do.
Shipyard, chimney of		26	39.43		47	12.88	do	Do.
New Salem, Dutch Reformed church		37	25.10		57	58.31	do	Do.
New Scotland, Presbyterian church tower.		37	53.91		54	24.41	do	Do.
Nine-mile Tree, light-house		31	05.22		45	53.64	do	Do.
Niskayuna		46	00.32		49	57.62	do	Do.
Nutter Hook		21	25.86		47	20.25	do	Do.
Olcott's house, cupola		37	53.02		43	13.11	do	Do.
Orchard		27	37.68		47	34.84	do	Do.
Paarda Hook		33	18.15		45	25.57	do	Do.
Papscanee Island		35	54.87		45	29.46	do	Do.
Parke		35	59.85		46	04.96	do	Do.
Parsons		27	09.59		47	31.39	do	Do.
Patten		15	27.72		47	10.01	do	Do.
Patterson		36	13.07		45	49.75	do	Do.
South chimney of house		36	09.08		46	26.86	do	Do.
Powell		23	20.60		51	50.69	C. & G. S.	Bull. 122.
Railroad farm		17	37.63		47	50.96	S. S.	Rept. '87.
Railway		41	11.94		42	38.32	do	Do.
Race course		41	17.34		42	54.99	do	Do.
Rafinesque		47	21.15		36	58.82	C. & G. S.	Rept. '85.
Rexford Flats		51	23.23		53	50.53	S. S.	Do.
Riley		41	42.83		42	08.15	do	Do.
Roha Hook		29	06.10		47	23.72	do	Do.
Light-house		28	50.37		47	19.54	do	Rept. '87.
Rotterdam, Methodist Episcopal church.		46	47.49		57	29.91	do	Do.

NEW YORK—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43° ° ' "	73°-74° ° ' "		
Round Top.....	42 05 14.39	73 52 23.68	C. & G. S.....	
Rural Cemetery, Williams monument.....	41 54.00	44 15.20	S. S.....	Rept. '87.
Rysedorph.....	37 36.71	43 10.93	do.....	Do.
Sage.....	40 02.18	44 04.83	do.....	Do.
Schermerhorn Island.....	31 20.19	45 59.55	do.....	Do.
Schenectady:				
Armory, flag pole.....	48 36.81	56 18.97	do.....	Do.
Baptist church spire.....	48 56.80	56 23.58	do.....	Do.
First Dutch Reformed church spire.....	49 00.98	56 51.27	do.....	Do.
First Presbyterian church spire.....	49 02.78	56 42.69	do.....	Do.
German Methodist Episcopal church spire.....	48 56.74	56 12.16	do.....	Do.
St. George's Protestant Episcopal church spire.....	49 05.68	56 42.84	do.....	Do.
St. John's Roman Catholic church spire.....	48 51.34	56 30.20	do.....	Do.
St. John's German Roman Catholic church spire.....	48 40.28	56 25.57	do.....	Do.
Second Reformed church spire.....	48 53.28	56 23.44	do.....	Do.
State Street Methodist Episcopal church spire.....	48 42.34	56 21.95	do.....	Do.
Union College dome.....	49 02.35	55 49.33	do.....	Do.
Union School.....	49 01.08	56 32.88	do.....	Do.
Schodack, channel light-house.....	29 51.94	46 41.66	do.....	Do.
Schodack Island.....	30 27.07	46 21.22	do.....	Do.
Schodack Landing:				
Dutch Reformed church.....	28 49.38	46 13.01	do.....	Do.
Knickerbocker ice house, flag pole.....	28 24.79	46 25.96	do.....	Do.
Schoolhouse cupola, near Mull.....	30 24.00	47 17.00	do.....	Rept. '83.
Schuyler.....	42 20.88	42 30.58	do.....	Rept. '87.
Scotia:				
Baptist church spire.....	49 34.41	57 48.64	do.....	Do.
Dutch Reformed church tower.....	49 40.15	57 37.06	do.....	Do.
Seward.....	40 30.60	39 46.50	do.....	Do.
Shad Island.....	30 53.72	46 22.65	do.....	Do.
Shart.....	17 34.43	46 05.05	do.....	Do.
Sickels.....	22 57.58	46 58.63	do.....	Do.
Slingerland.....	37 35.41	51 58.26	do.....	Do.
Methodist Episcopal church spire.....	37 50.52	51 38.49	do.....	Do.
Stevens.....	19 20.65	47 13.84	do.....	Do.
Stockport.....	18 01.69	46 11.77	do.....	Do.
Railway station, chimney.....	18 37.36	46 20.63	do.....	Do.
Stone House.....	25 25.27	47 11.51	do.....	Do.
Stuyvesant.....	23 21.83	46 00.01	do.....	Do.
Light-house.....	24 41.02	46 43.04	do.....	Do.
Lutheran church.....	23 24.43	46 23.82	do.....	Do.
Reformed church tower.....	23 16.70	46 55.86	do.....	Do.
Teller.....	36 26.33	44 05.71	do.....	Do.
Ten Eyck.....	28 48.11	45 49.84	do.....	Do.
Terry.....	23 01.75	47 58.36	do.....	Do.
Thistle.....	24 55.23	46 29.83	do.....	Do.
Tracy.....	25 25.26	44 31.71	do.....	Do.
Traver.....	30 14.70	45 39.55	C. & G. S.....	
Troy:				
French Roman Catholic church.....	43 21.57	41 37.25	S. S.....	Do.
St. Mary's Roman Catholic church.....	43 28.86	41 30.99	do.....	Do.
Ninth Presbyterian church.....	44 31.07	41 04.93	do.....	Do.
Park Presbyterian church.....	43 25.19	41 37.86	do.....	Do.
St. John's convent.....	42 56.64	41 29.80	do.....	Do.
St. John's Protestant Episcopal church.....	43 32.21	41 39.63	do.....	Do.
St. Joseph's Provincial Seminary, northwest spire.....	43 45.89	40 59.03	do.....	Do.
St. Michael's Roman Catholic church.....	42 04.67	41 48.72	do.....	Do.
St. Paul's Protestant Episcopal church.....	43 45.61	41 27.17	do.....	Do.
St. Peter's church, Roman Catholic.....	44 16.84	41 07.76	do.....	Do.
State Street Methodist Episcopal church.....	43 58.55	41 16.82	do.....	Do.
Round chimney near east end of State dam.....	44 47.11	41 05.53	do.....	Do.
Troy cemetery, Wool's monument.....	45 40.34	40 12.75	do.....	Do.
University, northwest spire.....	42 43.00	41 00.00	do.....	Rept. '83.
Unionville, Dutch Reformed church spire.....	36 02.00	53 28.00	do.....	Do.
Upper Red Hook.....	01 24.50	50 40.45	C. & G. S.....	

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			73°-74°				
	°	'	"	°	'	"		
Van Alstyne	42	25	53.77	73	46	18.65	S. S.	Rept. '87.
Van Buren		23	17.97		43	38.34	do	Do.
Van Dalfson		23	01.48		47	31.77	do	Do.
Van Denburg		33	10.08		44	09.71	do	Do.
Vanderpoel		26	28.43		47	16.62	do	Do.
Vanderzer		32	33.12		46	24.18	do	Do.
Van Rensselaer (C. S.)		39	02.10		43	38.10	do	Do.
Van Slyke		23	47.92		47	54.72	do	Do.
Van Wie		34	54.98		45	22.71	do	Do.
Van Wie, stone light		35	05.70		45	29.59	do	Do.
Vineyard		20	13.56		47	21.03	do	Do.
Visehee Ferry, church spire		47	47.17		49	35.63	do	Do.
Vrooman		30	42.92		46	53.36	do	Do.
West Albany		40	38.00		46	30.00	do	Rept. '83.
West Ghent, Dutch Reformed church		17	33.81		43	03.60	do	Rept. '87.
West Troy :								
Baptist church		43	41.89		42	11.79	do	Do.
Dutch Reformed church		42	48.83		42	33.95	do	Do.
First Dutch Reformed church		43	33.88		42	05.80	do	Do.
St. Bridget Roman Catholic church		42	53.48		42	27.60	do	Do.
Westertoe Island		37	20.13		45	40.82	do	Do.
Whannel		27	02.56		46	00.26	do	Do.
Whitehead's barn, west gable		21	31.47		46	45.66	do	Do.
Winnie's Dock		33	53.94		45	16.96	do	Do.
Winnie's Point		33	17.00		45	26.00	do	Rept. '83.
Wiswall		14	49.09		48	53.57	do	Rept. '87.
Wood		21	54.72		46	53.82	do	Do.
Yellow Pine		29	28.72		40	27.90	C. & G. S.	
	42°-43°			74°-75°				
Adebahr	42	52	26.92	74	10	42.01	S. S.	Do.
Amsterdam :								
Academy		56	34.95		11	28.74	do	Do.
Roman Catholic church spire		56	06.68		11	17.15	do	Do.
Argusville		47	50.00		31	12.55	do	Do.
Auriesville, Dutch Reformed church		55	43.86		18	50.52	do	Do.
Babcock		37	46.70		15	59.91	do	Do.
Baracsourie		43	30.71		29	26.18	do	Do.
Barrow's (W. C.) house		47	53.15		20	47.80	do	Do.
Bell's (W. H.) house		47	30.60		19	48.22	do	Do.
Black		58	44.08		10	04.23	do	Do.
Bouck		37	42.41		18	51.26	do	Do.
Bramans Corner, Baptist church spire		47	49.00		15	05.00	do	Do.
Brandmill		54	32.14		02	38.36	do	Do.
Bronk		56	53.52		05	35.02	do	Do.
Canajoharie :								
Dutch Reformed church		54	18.25		34	12.92	do	
German Lutheran church		54	14.99		34	10.55	do	Do.
Nellis House		54	22.22		34	20.74	do	Do.
Protestant Episcopal church		54	14.70		34	19.38	do	Do.
Chapman		47	19.44		13	18.47	do	Do.
Charleston Four Corners, church tower		48	50.00		24	46.00	do	Rept. '83.
Cobleskill :								
Hotel Augusta		40	41.44		29	06.05	do	Rept. '87.
Lutheran church		40	43.06		28	57.07	do	Do.
Carlisle, Presbyterian church		45	23.66		26	44.79	do	Do.
Catskill		11	23.85		02	14.59	C. & G. S.	Do.
Mountain House, southeast corner		11	41.00		02	06.60	S. S.	Do.
Conover		46	58.61		17	26.66	do	Do.
Currytown, Dutch Reformed church tower		51	35.17		28	09.65	do	Do.
Dockstader		45	25.37		40	07.69	do	Do.
Dougal		53	08.97		07	21.63	do	Do.
Duanesburg, church tower		46	10.00		09	25.00	do	Rept. '83.
Dunn Hill		59	26.38		22	16.02	do	Do.
Dunnsville :								
Flag pole		44	23.00		01	03.00	do	Do.
Dutch Reformed church west of		45	07.00		02	44.00	do	Do.
East Hill, primary		46	53.00		42	16.00	do	Do.
East Township, Baptist church spire		42	13.00		05	42.00	do	Do.
Esperance :								
Methodist Episcopal church		45	39.44		15	29.08	do	Rept. '87.
Presbyterian church		45	44.40		15	39.79	do	Do.
Failing		55	29.50		33	21.54	do	Do.
Finkel		47	00.72		29	02.00	do	Do.
Fonda		57	23.23		22	19.15	do	Do.
Court-house dome		57	13.05		22	34.29	do	Do.

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			74°-75°				
	°	'	"	°	'	"		
Fort Plain :								
Clinton Liberal Institute	42	55	54.23	74	37	47.90	S. S.	Rept. '87.
Dutch church spire		55	53.73		37	41.39	do	Do.
Methodist Episcopal church spire		55	56.57		37	31.81	do	Do.
Freys Bush, Methodist Episcopal church spire.		54	36.51		40	04.57	do	Do.
Fultonville, J. H. Starin's house cupola.		56	34.95		21	54.72	do	Do.
Glen		53	22.60		19	25.97	do	Do.
Dutch Reformed church spire		53	41.88		20	31.47	do	Do.
German Evangelical church tower		57	29.00		31	07.00	do	Rept. '83.
Hagaman Mills, church		58	27.00		09	01.33	do	Rept. '87.
Helderberg (C. S.)		37	39.07		00	38.47	do	Do.
High Peak		10	05.00		05	42.00	do	Rept. '83.
Holmes		37	36.10		30	49.79	do	Rept. '87.
Hunter		10	39.50		13	49.31	G. S.	Bull. 122.
Kelsey		37	32.38		21	54.68	S. S.	Rept. '87.
Knowersville		42	12.02		02	00.58	do	Do.
Lutheran church		42	11.87		02	01.64	do	Do.
Knox		59	08.45		05	47.39	do	Do.
Knoxville :								
Methodist Episcopal church spire		40	23.00		06	18.00	do	Rept. '83.
Lutheran church spire, 2 miles east of town.		40	38.00		04	45.00	do	Do.
Little Falls, Universalist church		02	34.00		51	27.00	do	Do.
Mann		41	04.98		19	05.23	do	Rept. '87.
Mannys Corners, church		56	50.56		08	42.36	do	Do.
Mapletown		49	48.60		33	14.08	do	Do.
Dutch Reformed church tower		50	20.75		33	33.26	do	Do.
Middleburg, Dutch Reformed church spire.		36	18.51		20	16.23	do	Do.
Methodist Episcopal church spire		35	48.97		19	58.73	do	Do.
Monument 46 (C. B.)		44	24.81		05	54.74	do	Do.
Monument 52 (C. B.)		43	00.11		14	29.35	do	Do.
Monument 53 (C. B.)		49	48.96		13	14.96	do	Do.
Monument 74 (C. B.)		45	04.97		00	23.71	do	Do.
Nellis		58	46.00		37	15.55	do	Do.
Oak Ridge		47	28.11		19	19.98	do	Do.
Wasson C. Barlow's house		47	52.00		20	49.00	do	Rept. '83.
Old Palatine, church spire		58	08.63		37	42.88	do	Rept. '87.
Ostego (C. S.)		46	54.73		42	14.60	do	Do.
Ostrander		57	25.44		48	26.10	do	Do.
Overlook Mountain		05	05.00		05	33.00	do	Rept. '83.
Paine Hollow, Methodist Episcopal church.		57	39.35		54	14.06	do	Rept. '87.
Palatine, German Evangelical church tower.		57	29.95		31	05.90	do	Do.
Pisgah		22	39.18		14	43.27	G. S.	Bull. 122.
Princeton		50	46.53		05	47.28	S. S.	
Presbyterian church spire		48	25.00		04	47.00	do	Rept. '83.
Reaman		53	47.42		35	45.40	do	Rept. '87.
Richfield Springs, observatory		50	33.15		56	58.57	do	Do.
Richmondville, hotel flag pole		38	02.00		33	53.00	do	Rept. '83.
Rickard		58	21.29		31	28.21	do	Rept. '87.
Riders Corners, church tower		58	43.44		38	44.57	do	Do.
Romeyn		54	42.12		05	11.75	do	Do.
Rundell		27	15.27		03	04.84	G. S.	Bull. 122.
Saltman's (Ezra L.) house, cupola		57	14.73		33	15.26	S. S.	Rept. '87.
St. Johnsville :								
Methodist Episcopal church spire		59	57.39		40	44.48	do	Do.
Union church tower		59	57.01		40	50.16	do	Do.
Schoharie :								
Cemetery, Williams monument		39	47.22		18	34.85	do	Do.
Lutheran church spire		39	53.01		18	40.21	do	Do.
Old Fort flag pole		40	38.64		18	08.02	do	Do.
Schuyler		58	54.72		26	35.71	do	Do.
Scotch Union, Presbyterian church spire.		52	18.87		08	09.16	do	Do.
Sears		43	44.08		14	43.81	do	Do.
Sharon Springs Hotel, window in gable.		47	52.00		36	49.00	do	Rept. '83.
Shoemaker		59	39.86		54	25.79	do	Do.
Sittle Hill		44	06.07		02	09.33	do	Rept. '87.
Sloansville, Baptist church tower		45	26.19		19	51.30	do	Do.
Stirling		48	42.42		33	26.66	do	Do.
Stone Arabia :								
Dutch Reformed church cupola		56	34.07		33	23.93	do	Do.
Lutheran church tower		56	26.80		33	22.38	do	Do.
Summit		35	42.94		34	58.73	do	Do.
Thompson		39	23.19		32	10.97	do	Do.
Tilpaugh		46	19.82		27	31.39	do	Do.
Tribes Hill, Presbyterian church tower.		57	17.89		17	01.94	do	Do.

NEW YORK—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43°	74°-75°		
	° ' "	° ' "		
Turk	42 39 57.92	74 28 08.27	S. S.	Rept. '87.
Utsayantho	23 56.21	35 24.12	do	Do.
Van Apse (Abram) barn, cupola	56 24.59	23 34.70	do	Do.
Van Atten	54 18.07	00 15.60	do	Do.
Van Deusen	56 58.10	28 00.29	do	Do.
Vly	14 45.50	26 29.60	G. S.	Bull. 122.
Watersheet	51 49.16	04 13.98	S. S.	
West Amsterdam, Lutheran church tower.	58 44.26	16 55.77	do	Rept. '87.
Willet	58 32.84	41 29.42	do	Do.
Windham, High Peak	18 53.78	08 36.22	G. S.	Bull. 122.
Winne	43 49.55	02 32.48	S. S.	Rept. '87.
Yule	56 40.67	53 58.48	do	Do.
	42°-43°	75°-76°		
	° ' "	° ' "		
Babell	42 16 26.13	75 40 51.85	do	Do.
Fenner	57 23.96	44 35.93	do	Do.
Getman	59 19.60	01 43.73	do	Do.
Maine	13 15.35	58 44.80	do	Do.
Solon	37 42.04	59 10.38	do	Do.
Tassel	56 29.13	19 00.47	do	Do.
Windsor	06 10.26	44 47.29	do	Do.
	42°-43°	76°-77°		
	° ' "	° ' "		
Alpine, Methodist Episcopal church.	42 18 42.22	76 43 29.08	do	Do.
Ashland	01 54.62	47 01.88	do	Do.
Auburn, court-house dome	55 47.86	34 09.19	do	Do.
Barton	06 48.66	27 29.52	do	Do.
Brown	23 48.31	51 03.44	do	Do.
Burdett:				
Methodist Episcopal church	25 13.81	50 46.94	do	Do.
Presbyterian church	25 00.81	50 50.11	do	Do.
Cafferty	06 30.34	08 03.58	do	Do.
Catharine, Methodist Episcopal church.	18 46.23	46 58.58	do	Do.
Chemung	02 31.64	33 21.02	do	Do.
Clapp	58 11.87	02 19.08	do	Do.
Cortland:				
Baptist church	36 01.32	10 40.69	do	Do.
Normal School, east cupola	35 56.99	10 36.02	do	Do.
Wagon Company's chimney	35 58.38	10 15.94	do	Do.
Couch	17 56.13	48 32.43	do	Do.
Dryden	23 06.00	20 02.00	do	Rept. '83.
Do	28 07.19	20 01.20	do	Rept. '87.
Eddytown, Presbyterian church	31 17.13	55 47.12	do	Do.
Ellis	38 47.65	12 52.41	do	Do.
Elmira:				
First Methodist Episcopal church.	05 31.48	48 16.04	do	Do.
First Presbyterian church	05 28.28	48 16.59	do	Do.
Park Congregational church	05 21.45	48 32.97	do	Do.
Female College tower	05 54.21	48 50.68	do	Do.
Public School, No. 5	05 50.54	49 16.47	do	Do.
Richardson shoe factory clock tower.	05 19.32	48 21.18	do	Do.
St. Mary's Roman Catholic church.	04 36.50	48 22.30	do	Do.
St. Patrick's Roman Catholic church.	05 37.81	48 39.30	do	Do.
Trinity Protestant Episcopal church.	05 24.06	48 30.13	do	Do.
Enfield	27 15.48	35 59.22	do	Do.
Erin	10 16.22	37 48.81	do	Do.
Fabius	48 41.63	01 14.88	do	Do.
Giles	53 02.27	26 13.44	do	Do.
Green	59 18.78	01 49.23	do	Do.
Havana:				
Baptist church	20 41.81	50 50.33	do	Do.
Cook Academy	20 30.85	50 22.16	do	Do.
Court-house	20 44.41	50 59.66	do	Do.
Methodist Episcopal church	20 44.58	50 44.23	do	Do.
Presbyterian church	20 43.33	50 37.14	do	Do.
Protestant Episcopal church	20 40.15	50 59.02	do	Do.
Union school-house	20 40.52	50 38.76	do	Do.
Hawley	06 22.99	52 15.73	do	Do.
Hector	26 47.09	48 21.04	do	Do.
Homer:				
Academy cupola	38 08.81	10 48.00	do	Do.
Baptist church	38 04.20	10 48.76	do	Do.
Methodist Episcopal church	38 05.57	10 48.50	do	Do.
Presbyterian church	38 07.38	10 48.18	do	Do.
Hornby	15 42.78	59 38.72	do	Do.
Horseheads	09 59.05	49 32.14	do	Do.

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			76°-77°				
	°	'	"	°	'	"		
Horseheads—Continued.	42	09	55.79	76	49	20.03	S. S.	Rept. '87
Baptist church		09	58.97		49	20.31	do	Do.
Methodist Episcopal church		09	57.77		49	19.98	do	Do.
Presbyterian church		09	53.23		49	10.50	do	Do.
Protestant Episcopal church		59	52.95		17	26.55	do	Do.
Howlett		55	46.15		22	28.30	do	Do.
Hoxsie		36	42.74		08	40.05	do	Do.
Hubert		25	45.22		27	03.45	do	Do.
Hungerford								
Ithaca:								
Cornell University, barn cupola	26	58.12		28	45.87		do	Do.
McGraw Building	26	57.97		29	08.80		do	Do.
Sage Chapel	26	49.70		29	05.08		do	Do.
Sage College	26	45.24		29	02.06		do	Do.
Light-house dome	27	44.92		30	52.70		do	Do.
McGraw Fiske, house	27	03.28		29	18.29		do	Do.
Presbyterian church	26	32.12		29	56.93		do	Do.
Protestant Episcopal church	26	28.27		29	58.42		do	Do.
Roman Catholic church	26	24.64		30	03.15		do	Do.
Sprague fire-engine house, flag pole.	26	22.04		30	36.68		do	Do.
State Street Methodist Episcopal church.	26	22.57		30	07.79		do	Do.
Jacksonville, Methodist Episcopal church.	30	44.74		38	06.62		do	Do.
Kile	04	34.65		15	41.46		do	Do.
Maby	07	32.60		47	38.02		do	Do.
Mathews	07	30.65		50	34.80		do	Do.
Mitchel	56	35.05		31	46.27		do	Do.
Morehead	32	22.71		13	27.39		do	Do.
Moreland, Presbyterian church	18	28.25		54	34.67		do	Do.
Newfield	23	11.24		40	10.62		do	Do.
Niles	47	56.73		26	03.55		do	Do.
North Barton church	07	07.00		29	39.00		do	Rept. '83.
Oak Hill, Baptist church	05	21.90		27	07.62		do	Rept. '87.
Odessa:								
Free Will Baptist church	20	06.85		47	25.02		do	Do.
Wesleyan Methodist church	20	03.81		47	24.89		do	Do.
Orange	19	11.29		58	27.15		do	Do.
Ovid	40	43.43		49	18.22		do	Do.
Owego, court-house	42	06.08		15	47.00		do	Rept. '83.
Pompey Hill:								
Presbyterian church	53	58.97		00	57.34		do	Rept. '87.
Roman Catholic church	54	03.52		00	48.18		do	Do.
Reading Center:								
Baptist church	25	49.60		56	00.75		do	Do.
Methodist Episcopal church	25	51.36		56	00.99		do	Do.
Richford	23	47.15		13	20.84		do	Do.
Ripley	47	24.85		14	26.42		do	Do.
Rock Stream, church	28	19.94		55	45.06		do	Do.
Ross Hill, church	05	08.00		25	30.00		do	Rept. '83.
Seeley	58	33.42		22	11.68		do	Rept. '87.
Shafford, church	48	15.00		15	56.00		do	Rept. '83.
South Hill	25	49.04		29	45.28		do	Rept. '87.
Strader	21	41.50		52	03.36		do	Do.
Sugar Hill, Presbyterian church	21	45.13		59	26.03		do	Do.
Trumansburg:								
Baptist church	32	34.84		39	43.53		do	Do.
Methodist Episcopal church	32	26.06		39	30.10		do	Do.
Presbyterian church	32	28.63		39	33.00		do	Do.
Protestant Episcopal church	32	27.01		39	40.02		do	Do.
Turner	25	07.71		29	38.70		do	Do.
University	26	54.15		29	08.73		do	Do.
Van Dorns Corners, Methodist Episcopal church.	26	53.92		34	29.77		do	Do.
Virgil	29	34.06		08	24.95		do	Do.
Watkins:								
Academy	22	37.80		52	09.33		do	Do.
Court-house	22	36.50		52	16.49		do	Do.
Lake View Hotel	22	42.38		52	39.24		do	Do.
Methodist Episcopal church	22	50.90		52	20.53		do	Do.
Palmater's (O.) house	23	59.99		51	03.21		do	Do.
Presbyterian church	22	48.03		52	15.43		do	Do.
Protestant Episcopal church	22	47.89		52	16.56		do	Do.
Roman Catholic church	22	39.56		52	12.21		do	Do.
Watkins Glen observatory	22	33.40		52	29.73		do	Do.
West Dryden, church	31	02.21		24	54.07		do	Do.
White	08	30.17		29	18.65		do	Do.
	42°-43°			77°-78°				
Bristol	42	42	00.62	77	24	31.05	do	Do.
Gorham		48	54.11		10	54.82	do	Do.
Milo		35	16.32		01	46.62	do	Do.

NEW YORK—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43°	77°-78°		
	° / "	° / "		
Scottsville	42 59 59.29	77 42 37.59	L. S.	Final Rept.
Sproul	23 13.77	00 10.51	S. S.	Rept. '87.
Swale	12 16.23	29 28.02	do	Do.
Urbana	25 40.54	15 14.99	do	Do.
Worden	44 46.66	25 34.22	do	Do.
Batavia:	42°-43°	78°-79°		
Court-house dome	42 59 51.75	78 11 13.19	do	Do.
German Methodist Episcopal church spire.	59 45.29	10 56.40	do	Do.
Johnston Harvester Works, chimney.	59 36.26	10 25.84	do	Do.
Methodist Episcopal church spire.	59 50.66	10 53.59	do	Do.
Presbyterian church tower	59 47.93	10 45.62	do	Do.
Buffalo	53 03.18	52 41.83	L. S.	Final Rept.
Buffalo Plains	56 58.22	49 03.79	do	Do.
East base	59 19.57	48 32.98	do	Do.
Erie County:				
Buffalo light-house	52 40.10	53 24.00	do	Do.
Horseshoe light-house	52 52.50	54 56.20	do	Do.
Intersection of Michigan and Exchange streets, Buffalo.	52 41.10	52 14.30	do	Do.
Hamburg	46 50.61	51 31.92	do	Do.
Norris	59 23.95	06 56.96	S. S.	Rept. '87.
Richmond	35 16.65	52 37.69	G. S.	Bull. 122.
West Base	57 20.56	52 44.54	L. S.	Final Rept.
	42°-43°	79°-80°		
Barcelona	42 20 32.00	79 35 24.40	do	Do.
Brocton	24 07.00	28 41.80	do	Do.
Dunkirk:				
Chimney of Brook's Locomotive Works.	29 06.40	19 26.80	do	Do.
Light-house	29 37.80	21 15.80	do	Do.
New light-house	29 44.30	21 25.80	do	Do.
Dean	32 33.61	09 15.62	G. S.	Bull. 122.
Deering	25 49.50	14 19.03	do	Do.
Pierce	26 06.00	09 18.82	do	Do.
Prospect	19 29.50	29 59.60	L. S.	Final Rept.
Shefflin	36 38.41	00 30.72	G. S.	Bull. 122.
Silver Creek	31 13.94	13 27.81	L. S.	Final Rept.
Sturgeon Point	41 24.88	02 53.93	do	Do.
Westfield	16 25.30	37 30.71	do	Do.
High School	19 29.70	34 23.20	do	Do.
Methodist Episcopal church	19 26.50	34 33.20	do	Do.
	41°-42°	71°-72°		
Chocomount	41 16 48.06	71 57 48.05	C. & G. S.	Do.
Montauk	03 54.39	54 18.43	do	
Montauk, 2	03 54.38	54 18.50	do	Rept. '85.
	41°-42°	72°-73°		
Brown Hill	41 09 11.29	72 17 36.46	do	Do.
Great Gull Island	12 06.43	07 06.21	do	Do.
Horton Point	04 58.21	26 53.61	do	Do.
Mattituck Hills	00 08.46	34 29.75	do	Do.
Mount Prospect	15 21.51	00 35.93	do	Do.
Mount Prospect, 2	15 21.54	00 35.87	do	Do.
Shelter Island	04 38.99	21 39.79	do	Do.
	41°-42°	73°-74°		
Bailey	41 18 43.79	73 33 06.07	do	Do.
Bald Hill	30 05.88	55 03.94	do	Do.
Bancroft	33 41.11	31 42.69	do	Do.
Barnes	48 14.31	51 00.74	do	
Bingham	35 31.24	59 31.60	do	
Boice	55 54.81	49 31.30	G. S.	Bull. 122.
Brace Mountain, monument	02 39.91	29 34.88	C. & G. S.	
Briggs	34 35.88	31 49.10	do	
Bussing	09 36.33	40 47.58	do	
Buttermilk	06 36.44	48 38.90	do	
Chapel Light	43 08.30	31 07.20	do	
Clark monument	48 02.69	30 27.96	do	
Clove	41 18.57	41 36.06	do	
Corner Stone	02 58.38	29 15.96	do	
Dickerson	15 32.13	52 02.38	do	
East Bluff	56 21.21	28 18.02	do	
Fields West	02 17.38	43 34.48	do	
Golden Ridge	38 44.88	59 08.31	do	
Haines	54 37.74	34 08.07	do	
Hamlin	59 10.51	32 48.90	do	
High Tor	11 15.51	57 56.65	do	
Hook Mountain	07 27.34	54 43.15	do	
Hussey Hill	53 08.54	59 40.69	G. S.	Do.

NEW YORK—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			73°-74°				
	°	'	"	°	'	"		
Iron bolt, near 30 mile boundary stone.	41	43	08.36	73	30	51.65	C. & G. S.	Bull. 122.
Kingston City Hall		55	37.46		59	47.90	G. S.	
Lewisboro, Presbyterian church (1865).		16	24.03		33	17.57	C. & G. S.	
Lloyd		49	17.24		53	14.19	do	Do.
Merwin		14	09.09		19	57.60	do	
Monument stone		34	24.64		31	35.87	do	
Osborne		35	16.90		32	29.32	do	Do.
Plymouth		46	25.41		37	17.28	do	
Port Chester		00	09.16		40	22.77	do	
Poughkeepsie		41	18.00		53	24.00	do	
Preston		42	36.70		31	04.37	do	
Prospect		52	27.96		57	49.92	do	
Purdy		03	10.12		41	36.08	do	
Ridgefield Angle, monument stone		17	42.68		33	06.79	do	
Round Mountain		25	06.37		32	25.65	do	
Monument		25	11.91		32	20.53	do	
Sandford		01	13.46		39	56.96	do	
Spencers Corner, spire (1863)		57	45.62		30	08.69	do	
Stewart		46	13.66		58	09.96	do	Do.
Stratford Shoal (Middle Ground) light-house (1881-1885).		03	35.78		06	06.11	do	
Terry		56	22.29		58	19.53	do	
Traver		55	05.04		52	41.44	do	
Underhill		35	47.39		51	56.70	do	
Vervalin		41	21.52		50	54.79	do	
Warner		24	04.88		56	33.99	do	
Watermelon		21	53.81		43	16.37	do	
Wilton monument		12	46.07		28	56.40	do	
Wing monument stone		33	30.38		31	40.71	do	
	41°-42°			74°-75°				
	°	'	"	°	'	"		
Pink	41	54	04.50	74	02	46.89	G. S.	Do.
Prospect Hill		33	21.83		01	48.68	C. & G. S.	
Schuyler		58	54.73		26	35.72	S. S.	
Sky Top Tower		45	49.76		09	23.64	G. S.	
Slide		59	56.97		23	10.94	do	

NEW JERSEY.

	41°-42°			74°-75°				
	°	'	"	°	'	"		
Allendale church spire	41	01	49.56	74	07	34.74	C. & G. S.	Final Rept., Vol. 1.
Bald Mountain		07	14.54		12	02.91	do	Do.
Beach Mountain		10	00.16		17	40.09	do	Do.
Bear Fort		08	26.15		23	31.50	do	Do.
Beaver Run		09	21.00		38	46.77	do	Do.
Catfish Pond, summit, east of pond		01	57.42		59	50.19	do	Do.
Centerville		12	54.07		50	29.59	do	Do.
Culver Gap		10	20.99		47	42.03	do	Do.
Darlington		04	42.70		12	32.80	do	Do.
Decker Pond		12	14.34		32	02.25	do	Do.
Deckertown, Presbyterian church spire.		12	39.10		36	23.47	do	Do.
Dunker Pond		04	58.50		28	57.03	do	Do.
East and west Jersey line (on Blue Mountain).		08	46.65		50	59.68	do	Do.
Franklin furnace stack		06	32.22		35	21.34	do	Do.
Glenwood		15	27.31		30	17.51	do	Do.
Hamburg		08	53.35		31	49.78	do	Do.
High Point		19	15.24		39	42.98	do	Do.
High Torne		09	05.39		09	47.33	do	Do.
Lafayette		07	53.51		41	26.76	do	Do.
Macopin		02	56.21		24	03.59	do	Do.
Newton, Presbyterian church spire		03	27.30		45	18.60	do	Do.
Ramsey, church tower		03	33.61		08	32.10	do	Do.
Smith Hill		04	57.55		44	49.77	do	Do.
Sparta		00	58.46		38	15.64	do	Do.
Waykoff, church cupola		00	27.73		10	25.98	do	Do.
Woodport		00	40.05		35	29.96	do	Do.
	40°-41°			73°-74°				
	°	'	"	°	'	"		
Cherry Hill	40	54	45.91	73	58	12.17	do	Do.
Coytesville		51	37.59		58	45.27	do	Do.
Duer		59	53.46		54	10.37	do	Do.
Englewood		53	28.16		58	16.05	do	Do.
Fort Lee, flagstaff		50	49.00		57	53.76	do	Do.
Navesink		23	47.86		59	09.67	do	Do.

NEW JERSEY—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	40°-41° ° ' "	73°-74° ° ' "		
Navesink.....	40 23 18.14	73 59 13.40	C. & G. S.....	Final Rept., Vol. 1.
Lighthouse.....	23 45.23	59 08.52	do.....	Do.
Palisade.....	59 52.93	54 17.49	do.....	Do.
Schraalenburg, church spire.....	56 25.10	59 40.05	do.....	Do.
State line, stone on bank of Hudson River.	54 50.10	55 28.95	do.....	Do.
	40°-41° ° ' "	74°-75° ° ' "		
Allentown, Reformed church spire....	40 10 27.10	74 35 14.60	do.....	Do.
Andover.....	59 09.80	44 49.40	do.....	Do.
Aquackanonck.....	51 03.73	07 45.60	do.....	Do.
Arney.....	00 28.66	42 12.62	do.....	Do.
Baird.....	14 09.85	24 51.16	do.....	Do.
Bald Hill.....	57 39.81	21 03.61	do.....	Do.
Banta.....	53 12.54	00 59.46	do.....	Do.
Bay Way, Staten Chemical Co.'s chimney.	37 56.00	12 15.30	do.....	Do.
Bayard.....	35 01.66	12 43.94	do.....	Do.
Beacon Hill.....	22 26.55	13 41.91	do.....	Do.
Bedminster, church cupola.....	40 14.70	38 43.00	do.....	Do.
Beers Hill.....	23 33.76	11 26.19	do.....	Do.
Bergen, Dutch Reformed church.....	43 37.14	04 04.35	do.....	Do.
Bergen Fields, church spire.....	55 45.64	00 13.18	do.....	Do.
Bergen Neck.....	45 52.00	02 36.50	do.....	Do.
Bergen Point, spire.....	38 52.17	07 39.14	do.....	Do.
Bird.....	39 05.83	10 28.39	do.....	Do.
Bishop's barn.....	03 47.40	41 38.00	do.....	Do.
Bloomfield.....	32 06.71	19 28.84	do.....	Do.
Boonton, Presbyterian church spire.....	54 23.52	24 37.38	do.....	Do.
Bordentown, flag pole.....	08 52.95	42 49.59	do.....	Do.
Bordentown, Presbyterian church spire.	08 36.50	42 37.10	do.....	Do.
Bordentown Observatory.....	09 20.57	42 43.74	do.....	Do.
Bordentown, church spire.....	08 48.70	42 50.10	do.....	Do.
Bound Brook.....	34 59.36	31 57.27	do.....	Do.
Boynton's Tile Works, near Wood-bridge Landing.	32 26.58	15 21.56	do.....	Do.
Burdge.....	23 02.23	01 45.70	do.....	Do.
Burlington, St. Mary's spire.....	04 37.80	51 43.60	do.....	Do.
Bury.....	50 28.80	05 22.41	do.....	Do.
Caldwell, church spire.....	50 20.98	16 33.92	do.....	Do.
Caldwell.....	50 24.29	15 24.67	do.....	Do.
Do.....	50 24.10	15 24.70	do.....	Do.
Carhart.....	25 03.93	02 31.56	do.....	Do.
Caven Point.....	41 33.96	04 18.97	do.....	Do.
Centerville, church spire.....	40 05.83	06 53.16	do.....	Do.
Chapel Hill, back light.....	23 53.80	03 32.66	do.....	Do.
Chapel Hill, light-house pole.....	23 54.48	03 32.57	do.....	Do.
Cherryville, spire.....	33 44.70	54 15.50	do.....	Do.
Cherryville.....	33 45.15	54 31.01	do.....	Do.
Chestnaquack.....	27 40.13	15 03.39	do.....	Do.
Chestnaquack Point.....	27 39.58	15 02.36	do.....	Do.
Christopher.....	04 13.42	11 56.75	do.....	Do.
Claybanks.....	07 14.42	47 53.03	do.....	Do.
Cold Soil.....	20 40.64	42 33.50	do.....	Do.
Columbus, west spire.....	04 25.00	43 31.40	do.....	Do.
Compton.....	26 22.54	05 29.84	do.....	Do.
Conasconck Point.....	27 33.40	10 44.64	do.....	Do.
Conover.....	20 41.08	01 27.32	do.....	Do.
Conover beacon.....	25 17.01	03 21.29	do.....	Do.
Constable Point.....	39 26.12	05 45.51	do.....	Do.
Cornhill.....	22 23.78	54 42.70	do.....	Do.
Cranbury:				
First Presbyterian church steeple.....	18 26.38	31 08.32	do.....	Do.
Second Presbyterian church spire.....	18 50.40	30 51.60	do.....	Do.
Crane.....	50 08.02	13 08.76	do.....	Do.
Cranford, Presbyterian church spire.....	39 28.10	18 11.60	do.....	Do.
Crosswick, spire.....	09 16.30	39 02.10	do.....	Do.
Croton.....	29 04.12	54 45.55	do.....	Do.
Cushetunk.....	37 24.80	48 26.90	do.....	Do.
Danville.....	52 12.03	56 12.86	do.....	Do.
Dayton, church spire.....	22 32.80	30 43.70	do.....	Do.
Debow hill.....	10 58.17	25 36.79	do.....	Do.
Delanco.....	02 46.15	57 46.20	do.....	Do.
Delanco, church spire.....	02 58.11	57 25.15	do.....	Do.
Disboro Hill.....	14 48.23	27 26.00	do.....	Do.
Dunellen, spire.....	35 39.90	27 50.20	do.....	Do.
Dutch Neck, spire.....	16 57.50	36 50.30	do.....	Do.
East and west Jersey line.....	53 49.06	44 54.13	do.....	Do.
East Millstone, Reformed church cupola.	30 10.14	34 47.35	do.....	Do.
East Trenton, Rubber Works chimney	14 23.00	43 39.00	do.....	Do.

NEW JERSEY—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	40°-41°			74°-75°				
	°	'	"	°	'	"		
Elizabeth:								
First Presbyterian church spire	40	39	45.60	74	12	56.80	C. & G. S.	Final rept., Vol. 1.
St. Mary's church spire	39	29	90	13	07	80	do	Do.
Elizabethport Oil Cloth Co.'s chimney.	38	45	96	11	45	84	do	Do.
Elizabethport, spire Presbyterian church.	38	52	45	11	27	94	do	Do.
Elizabethtown, spire First Presbyterian church.	39	45	54	12	56	67	do	Do.
Ewing, church spire	16	14	40	48	02	50	do	Do.
Fairfield, spire Reformed church	53	04	54	16	58	03	do	Do.
Fleming	00	15	97	03	31	97	do	Do.
Flemington, spire Methodist church	30	20	23	51	30	22	do	Do.
Florence, foundry chimney	07	31	10	49	05	60	do	Do.
Fox Hill	43	59	01	48	19	05	do	Do.
Freehold, spire old court-house	15	37	18	16	28	40	do	Do.
Freehold, spire Reformed church	15	28	00	16	42	40	do	Do.
Garriell	20	34	44	03	05	72	do	Do.
Gibbet Island	41	58	32	02	25	39	do	Do.
Goat Hill	20	44	75	56	17	05	do	Do.
Grandon Hill	15	47	42	13	55	76	do	Do.
Green Island	00	35	22	06	26	49	do	Do.
Green Pond	58	33	64	32	01	63	do	Do.
Hackensack, church spire	53	18	55	02	32	65	do	Do.
Hackettstown	51	08	08	52	19	41	do	Do.
Hamilton Square, Baptist church	13	46	10	39	37	30	do	Do.
Hardwick, church cupola	59	44	10	51	39	00	do	Do.
Harrison House, cupola	02	22	67	59	47	93	do	Do.
Hawk	33	41	77	14	25	40	do	Do.
Do	02	35	95	58	39	21	do	Do.
Hazel's farm	18	05	57	40	28	29	do	Do.
High Mountain	58	14	12	11	55	38	do	Do.
Highwood	46	12	70	01	02	06	do	Do.
Highland of Squan	06	10	48	04	37	60	do	Do.
Hilton	25	19	99	03	29	34	do	Do.
Hope, church spire	54	31	90	58	11	70	do	Do.
Hunter House, north chimney	00	47	91	59	07	46	do	Do.
Jenny Jump Mountain	52	02	20	59	20	80	do	Do.
Jersey City:								
Spire	42	53	18	02	16	75	do	Do.
Flagstaff	42	55	03	02	17	10	do	Do.
Key East Hotel, flagstaff	11	29	60	00	37	80	do	Do.
Keyport, spire	26	15	21	12	07	14	do	Do.
Kill von Kull Oil Cloth Co.'s chimney.	39	18	82	06	33	44	do	Do.
Kills Light, Bergen Point	38	34	83	08	55	74	do	Do.
King	01	21	05	56	29	70	do	Do.
Kingsland	47	47	76	07	32	55	do	Do.
Lamington, church spire	39	38	20	43	12	20	do	Do.
Lawrenceville	18	07	81	44	08	31	do	Do.
Standpipe	17	31	90	44	10	90	do	Do.
Spire	17	53	80	43	44	85	do	Do.
Liberty pole, Long Branch village	17	58	35	00	12	20	do	Do.
Light-house flag	26	53	55	07	16	71	do	Do.
Linden, spire Episcopal church	37	39	70	15	07	00	do	Do.
Linden, spire Reformed church	38	02	60	15	32	20	do	Do.
Lippincott, hill	15	20	43	07	49	81	do	Do.
Mapleton	21	11	42	36	43	43	do	Do.
Matayan	26	51	67	12	38	80	do	Do.
Matayan Point	26	53	08	12	39	43	do	Do.
Mechanicsville, church spire	37	11	20	45	00	40	do	Do.
Menlo Park, tall iron stack	33	49	00	20	22	50	do	Do.
Metuchen, spire Presbyterian church	32	25	70	21	34	50	do	Do.
Middlebush, church spire	29	49	87	31	42	81	do	Do.
Midland Park, church tower	59	26	80	08	31	60	do	Do.
Mine Mount	43	19	05	36	20	28	do	Do.
Morgan	28	03	76	15	59	33	do	Do.
Do	28	10	75	15	56	15	do	Do.
Do	28	07	88	15	53	80	do	Do.
Morristown, spire Presbyterian church.	47	50	43	28	49	89	do	Do.
Mount Canoe	19	40	56	51	39	58	do	Do.
Mount Holly	00	09	12	47	19	30	do	Do.
Mount Horeb	36	42	07	34	16	27	do	Do.
Mount Mitchell, north edge of Highlands.	24	30	57	00	26	20	do	Do.
Mount Olive	52	02	48	42	52	50	do	Do.
Mount Rose	22	03	36	43	25	74	do	Do.
Netherwood	37	33	70	24	00	40	do	Do.
New Brunswick:								
Rutgers College cupola	29	55	43	26	48	12	do	Do.
Spire St. James	29	38	00	26	53	30	do	Do.

NEW JERSEY—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	40°-41°			74°-75°				
	°	'	"	°	'	"		
New Dover, spire.....	40	35	07.20	74	20	26.40	C. & G. S.	Final rept., Vol. 1.
Newark:								
Spire Methodist church.....	44	06	18	10	12	50	do	Do.
Spire First Presbyterian church..	44	03	78	10	22	16	do	Do.
Spire Episcopal church.....	44	25	42	10	10	35	do	Do.
Bay light or Passaic light.....	41	46	29	07	39	13	do	Do.
Bay beacon	42	08	20	07	27	87	do	Do.
Neck	42	47	57	08	19	90	do	Do.
Newell	11	43	95	14	25	67	do	Do.
North Branch.....	35	55	35	40	53	28	do	Do.
Spire Reformed church.....	35	56	60	40	22	20	do	Do.
Ocean Beach, Colorado House	10	23	80	00	57	50	do	Do.
Ocean House, flagstaff.....	22	54	54	58	33	80	do	Do.
Palmerpaw	40	40	84	05	59	22	do	Do.
Paramus, church spire	59	07	12	05	33	28	do	Do.
Parsippany, church spire	51	52	70	24	24	20	do	Do.
Parsippany, spire Presbyterian church.....	51	52	77	24	23	87	do	Do.
Passionist Fathers' Monastery, West Hoboken.....	45	56	98	02	12	18	do	Do.
Pennington Seminary, cupola.....	19	38	16	47	37	90	do	Do.
Perth Amboy, spire Episcopal church..	30	13	34	15	56	15	do	Do.
Perth Amboy, Presbyterian church ..	30	20	79	15	57	80	do	Do.
Pickles	35	40	96	49	26	17	do	Do.
Pigeon Hill.....	24	27	90	04	43	23	do	Do.
Pleasant Corner, church spire	26	28	63	51	24	15	do	Do.
Pluckamin, church spire	38	52	60	38	32	50	do	Do.
Plum	01	56	99	59	26	61	do	Do.
Point Comfort	27	23	59	08	04	95	do	Do.
Polhemus	19	02	80	08	56	52	do	Do.
Poplar Ridge.....	22	17	10	42	30	35	do	Do.
Pottersville	42	24	80	44	06	10	do	Do.
Powder Mills, machine-shop chimney..	55	30	11	16	33	39	do	Do.
Princeton College, cupola	20	54	86	39	34	86	do	Do.
Do	20	55	00	39	35	10	do	Do.
Princeton Seminary, cupola.....	20	42	80	39	53	86	do	Do.
Princeton water tower.....	20	23	50	40	03	50	do	Do.
Quakertown, spire.....	33	52	90	56	31	50	do	Do.
Rahway, spire First Presbyterian church.....	36	31	80	16	34	10	do	Do.
Do	36	53	74	16	51	81	do	Do.
Do	36	53	80	16	51	80	do	Do.
Rancocas	02	36	10	58	40	44	do	Do.
Randolph	36	44	51	23	40	02	do	Do.
Raritan woolen mill chimney	33	54	72	37	57	02	do	Do.
Readington, spire Reformed church..	34	05	16	44	09	19	do	Do.
Readington, church spire.....	34	05	20	44	09	20	do	Do.
Red Bog	14	06	08	03	14	06	do	Do.
Do	14	05	81	03	13	71	do	Do.
Robbins Reef light.....	39	26	45	03	56	68	do	Do.
Roselle, flagstaff	39	37	00	15	50	40	do	Do.
Rosemont, spire.....	25	39	40	59	26	40	do	Do.
Rowan	38	54	14	07	33	62	do	Do.
Sand Ridge, spire Baptist church.....	25	23	15	57	14	59	do	Do.
Sandhills	24	30	00	32	39	08	do	Do.
Sandy Hook	27	44	98	00	24	70	do	Do.
Signal	28	19	85	00	23	11	do	Do.
Light-house	27	42	29	00	08	46	do	Do.
Sawyer, Tufts Point.....	33	38	86	13	26	27	do	Do.
Sayre, hill.....	40	46	26	17	17	28	do	Do.
Schooley Mountain	49	47	53	47	33	15	do	Do.
Schuyler	46	48	88	08	30	07	do	Do.
Sea Girt, Beach House, north flagstaff.	07	34	80	01	49	90	do	Do.
Seward	28	55	60	16	33	05	do	Do.
Hill	47	12	80	40	35	20	do	Do.
Sewaren	32	47	50	15	18	54	do	Do.
Sheep Hill	55	09	18	24	24	05	do	Do.
Shooter's Island	38	36	84	09	39	94	do	Do.
Chimney	38	32	58	09	39	70	do	Do.
Shotwell	32	48	13	15	21	06	do	Do.
Shrewsbury, spire.....	19	25	00	03	41	53	do	Do.
Springfield	41	22	14	21	25	14	do	Do.
Somerville, spire First Reformed church.....	34	06	48	36	41	42	do	Do.
South Amboy, depot Pennsylvania R. R.	29	29	02	16	35	58	do	Do.
Do	28	47	31	17	19	98	do	Do.
Sourland	25	51	66	45	39	10	do	Do.
Standard Chemical Co., chimney	36	54	00	12	21	73	do	Do.
State Reform School, tower	20	35	60	23	55	60	do	Do.
Staten Chemical Co., chimney	37	55	90	12	15	47	do	Do.

NEW JERSEY—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	40°-41°			74°-75°				
	°	'	"	°	'	"		
Stelton, church spire	40	31	01.50	74	24	26.00	C. & G. S.	Final Rept., Vol. 1.
Stevens.....	44	41.09		01	26.44		do	Do.
Do	44	41.14		01	26.44		do	Do.
Taylor Mount.....	02	03.60		33	01.90		do	Do.
Terhune.....	51	40.71		04	56.66		do	Do.
Three Bridges, church spire	31	23.23		47	49.49		do	Do.
Throckmorton	15	03.90		10	48.57		do	Do.
Tottenville.....	30	30.90		14	37.90		do	Do.
Tranquility, church spire.....	56	38.70		48	14.00		do	Do.
Trenton:								
Spire First Presbyterian church.....	13	13.13		45	49.18		do	Do.
Spire Roman Catholic church.....	12	51.50		45	40.60		do	Do.
Spire Methodist church.....	13	13.50		45	36.70		do	Do.
Spire Baptist church.....	12	41.40		45	36.40		do	Do.
Statehouse dome.....	13	13.80		46	13.10		do	Do.
Spire, State and Clinton streets.....	13	16.80		45	21.30		do	Do.
Van Kensen's house, 1 mile south of Newton.....	32	16.40		28	06.20		do	Do.
Van Riper.....	53	36.64		08	24.14		do	Do.
Vanhorne.....	39	08.23		08	26.70		do	Do.
Vreeland.....	50	00.72		00	39.47		do	Do.
Wallace.....	44	33.01		11	15.99		do	Do.
Warrenville.....	53	53.00		50	21.60		do	Do.
Washington, old chimney, bank of canal.....	45	55.60		59	17.20		do	Do.
Washington Hunter.....	00	55.51		59	08.33		do	Do.
Do	00	55.73		59	16.80		do	Do.
Washington Rock.....	36	45.70		28	20.90		do	Do.
Watnong.....	50	55.48		29	39.93		do	Do.
Wayne, chimney powder mill.....	55	30.10		16	33.50		do	Do.
Weasel.....	52	36.81		11	12.21		do	Do.
Westfield, spire Presbyterian church.....	39	14.10		20	52.70		do	Do.
White Hall.....	42	29.40		54	00.60		do	Do.
White Hill.....	08	22.49		43	53.26		do	Do.
White Horse.....	11	13.50		42	27.11		do	Do.
Williams.....	34	53.88		12	51.94		do	Do.
Wilson.....	26	21.67		05	28.82		do	Do.
Wilson Beacon.....	26	38.60		08	11.22		do	Do.
Windsor, spire.....	14	34.50		34	57.70		do	Do.
Woodbridge.....	33	25.21		14	40.83		do	Do.
Spire Presbyterian church.....	33	42.50		16	25.94		do	Do.
Landing.....	32	45.93		15	19.71		do	Do.
Woodside.....	03	47.52		49	34.03		do	Do.
Wynant.....	32	57.98		14	18.59		do	Do.
Do	36	27.11		13	11.48		do	Do.
Zellis.....	32	45.72		16	37.64		do	Do.
	39°-40°			74°-75°				
Absecon.....	39	25	12.43	74	29	27.03	do	Do.
Absecon light-house.....	21	58.74		24	52.27		do	Do.
Apple Pie Hill.....	48	26.62		35	23.83		do	Do.
Atco.....	46	17.70		53	08.20		do	Do.
Atsion Mill tower.....	44	21.50		43	30.60		do	Do.
Balcony.....	55	27.09		23	40.94		do	Do.
Barnegat Inlet.....	45	58.47		06	15.43		do	Do.
Barnegat light-house.....	45	51.61		06	23.78		do	Do.
Barnegat, Methodist church spire.....	45	09.81		13	20.04		do	Do.
Beasley.....	17	02.53		37	00.20		do	Do.
Beasley Point.....	16	50.11		37	41.08		do	Do.
Berlin.....	48	55.85		54	45.07		do	Do.
Blackman.....	15	07.94		39	33.53		do	Do.
Blangie.....	28	44.36		41	16.71		do	Do.
Bridgeway, summit.....	46	34.43		19	33.26		do	Do.
Brigantine Beach.....	25	52.68		19	57.31		do	Do.
Brown Mill Observatory.....	58	09.50		34	53.30		do	Do.
Buckingham.....	55	57.90		28	30.80		do	Do.
Buena Vista.....	30	50.60		55	29.70		do	Do.
Cape May, court-house spire.....	04	53.00		49	29.00		do	Do.
Carlisle.....	12	06.52		57	07.80		do	Do.
Cedar.....	13	34.08		38	12.08		do	Do.
Cedar Creek.....	51	47.44		08	12.94		do	Do.
Cedar Hummock.....	34	10.58		20	39.31		do	Do.
Corson.....	12	01.01		39	21.35		do	Do.
Cramer.....	35	12.24		13	12.76		do	Do.
Cranberry.....	56	40.21		04	18.55		do	Do.
Crese.....	03	03.25		49	48.51		do	Do.
Cyrus.....	04	31.75		44	20.80		do	Do.
Dinner Point.....	38	00.40		15	14.94		do	Do.
Double Creek.....	44	27.84		10	40.39		do	Do.
Doughty's tavern.....	26	53.96		51	46.69		do	Do.
Dry Inlet.....	20	34.98		28	17.72		do	Do.
Eldridge.....	09	06.63		47	36.46		do	Do.

NEW JERSEY—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	°	'	"	°	'	"		
Elwood	39	34	40.33	74	42	55.55	C. & G. S.	Final Rept., Vol. 1.
English Creek	22	18.30		39	18.30		do	Do.
Estellville	22	21.40		45	44.10		do	Do.
Evesham, summit of Mount Laurel ..	56	03.45		53	40.41		do	Do.
Fish	18	39.50		32	34.26		do	Do.
Fishing Creek	01	07.28		56	51.86		do	Do.
Forked River	49	22.83		09	28.41		do	Do.
Four Mile	53	08.70		34	11.60		do	Do.
Gibbsboro	50	20.57		56	59.38		do	Do.
Good Luck Point	55	21.58		07	07.10		do	Do.
Goose Creek	57	07.97		06	40.38		do	Do.
Goshen	07	39.64		53	30.63		do	Do.
Gowdy's house, cupola	57	11.73		10	34.90		do	Do.
Great Swamp	40	42.53		08	59.32		do	Do.
Grore	20	03.74		30	17.18		do	Do.
Hammock	07	00.00		53	30.65		do	Do.
Hammonton	38	48.05		49	19.29		do	Do.
Heart	15	34.23		38	35.80		do	Do.
Hickey	37	37.20		11	23.36		do	Do.
Hickory Island	41	14.94		13	03.12		do	Do.
Holmes	07	35.91		46	13.33		do	Do.
Huckleberry	51	24.50		44	15.70		do	Do.
Island Beach	49	05.52		05	28.73		do	Do.
Isle	10	36.65		40	32.66		do	Do.
Jemima, Mount	43	43.00		27	04.10		do	Do.
Kellogg	26	00.50		59	09.80		do	Do.
Leaming Beach, north	06	29.26		42	32.14		do	Do.
Leaming Point	00	59.84		51	18.08		do	Do.
Leed Point	29	02.37		26	00.00		do	Do.
Leedsville	20	55.88		33	39.42		do	Do.
Do	20	56.52		33	40.28		do	Do.
Lewistown, windmill	59	26.90		37	11.70		do	Do.
Limerick	05	43.37		43	23.69		do	Do.
Linwood	20	54.06		33	38.76		do	Do.
Little Egg Harbor light	30	22.11		17	08.32		do	Do.
Long Beach	33	18.89		14	41.23		do	Do.
Ludlam Beach	08	44.70		41	49.29		do	Do.
Ludlam Landing	10	41.75		51	09.74		do	Do.
Do	10	41.66		51	09.60		do	Do.
Marlton, church tower	53	26.30		55	10.70		do	Do.
Marshall	12	13.47		41	47.00		do	Do.
Martha	40	35.87		28	13.12		do	Do.
McCrea	09	52.62		50	45.96		do	Do.
Medford	54	55.30		51	13.50		do	Do.
Miry Run	23	26.50		41	35.60		do	Do.
Moorestown, Episcopal church spire ..	57	45.27		57	01.69		do	Do.
Mount Laurel	56	03.50		53	39.30		do	Do.
Mountain Creek	11	46.00		39	11.34		do	Do.
Muskee Hill	18	42.20		57	08.20		do	Do.
New Germany	36	26.48		50	49.07		do	Do.
New Inlet	19	12.19		30	50.95		do	Do.
Nummy Island	01	42.70		47	28.91		do	Do.
Ocean	17	18.69		34	13.14		do	Do.
Oyster Creek	30	27.04		24	35.04		do	Do.
Page	59	09.18		07	08.18		do	Do.
Pecks Beach	16	14.97		35	11.12		do	Do.
Peters Beach	23	20.20		24	21.90		do	Do.
Phillip	53	53.37		04	45.90		do	Do.
Pierce Landing	04	57.53		54	25.38		do	Do.
Pine Hill	47	54.03		59	36.00		do	Do.
Piny Hollow	35	09.90		55	39.70		do	Do.
Public	09	03.43		44	48.17		do	Do.
Retreat, hill	53	52.20		41	47.70		do	Do.
Richland	29	18.96		51	12.59		do	Do.
Risley Landing	22	52.45		31	31.79		do	Do.
River	18	23.07		37	12.11		do	Do.
Road	15	05.28		36	53.77		do	Do.
Robinson	11	26.83		59	42.30		do	Do.
Russia	22	46.20		48	32.90		do	Do.
Ryon	22	45.09		31	33.70		do	Do.
Sea	08	59.50		42	15.64		do	Do.
Seaside Park, flagstaff at post-office ..	55	15.50		04	44.00		do	Do.
Smithville, mill tower	59	10.70		44	54.70		do	Do.
Somers	18	42.68		35	23.39		do	Do.
Somers Point	18	42.48		35	23.25		do	Do.
Stipson	11	54.61		54	37.91		do	Do.
Stipson Island	11	54.67		54	38.00		do	Do.
Stout	57	37.71		04	35.43		do	Do.
Tatham	06	20.34		43	31.72		do	Do.
Taunton, Hunchman's store cupola ..	51	12.10		51	21.40		do	Do.
Town Bank, hotel cupola	59	14.32		57	30.84		do	Do.

NEW JERSEY—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	39°-40°			74°-75°				
	°	'	"	°	'	"		
Townsend.....	39	10	27.04	74	43	29.58	C. & G. S.	Final Rept., Vol. 1.
Tuckahoe, spire.....	17	32.40		45	17.60		do	Do.
Tuckerton.....	36	10.16		19	47.82		do	Do.
View.....	10	39.38		43	11.40		do	Do.
Waterford, spire.....	43	23.90		51	09.40		do	Do.
Weakfish Creek.....	13	32.00		37	58.33		do	Do.
Weeks Landing.....	58	58.79		53	09.20		do	Do.
West Creek.....	10	30.30		55	04.47		do	Do.
Do.....	10	37.79		54	58.35		do	Do.
Weymouth.....	31	02.18		46	48.46		do	Do.
Stack.....	30	23.50		46	36.00		do	Do.
Whiting's Hotel flagstaff.....	57	13.04		22	46.62		do	Do.
Young.....	13	48.24		40	19.20		do	Do.
	39°-40°			75°-76°				
Acton.....	39	38	11.81	75	23	04.72	do	Do.
Allen.....	41	17.34		22	47.66		do	Do.
Alloway.....	30	15.97		31	48.92		do	Do.
Do.....	30	08.53		31	48.25		do	Do.
Arnold.....	23	17.37		25	55.00		do	Do.
Do.....	23	17.98		25	59.89		do	Do.
Do.....	23	18.03		25	59.93		do	Do.
Do.....	23	18.65		25	54.34		do	Do.
Baker.....	26	19.86		22	05.34		do	Do.
Barker.....	26	19.96		22	05.40		do	Do.
Ben.....	17	18.47		17	26.97		do	Do.
Ben Davis.....	17	15.36		17	29.10		do	Do.
Big Island.....	19	48.71		18	33.48		do	Do.
Big Mannington Hill.....	36	57.29		21	41.19		do	Do.
Big Timber Creek.....	52	45.78		08	04.94		do	Do.
Billingsport.....	51	03.34		14	35.28		do	Do.
Bird Island.....	11	47.61		01	29.58		do	Do.
Bombay Hook light-house.....	21	49.49		30	38.34		do	Do.
Bradford Point.....	15	56.35		11	53.95		do	Do.
Bridgeton, Baptist church spire.....	25	43.20		13	58.10		do	Do.
Bridgeton, Chas. R. Elmer's house cupola.....	25	37.20		12	50.50		do	Do.
Bridgeton spire.....	25	46.48		13	57.71		do	Do.
Buck.....	25	10.71		13	36.54		do	Do.
Burden.....	31	48.94		22	52.80		do	Do.
Bush.....	23	59.79		15	43.25		do	Do.
Caffery.....	47	31.54		13	19.13		do	Do.
Camden.....	56	44.06		07	29.69		do	Do.
Cedarville.....	20	38.48		11	50.65		do	Do.
Spire.....	20	01.99		12	07.72		do	Do.
Centerton.....	31	45.30		07	44.40		do	Do.
Chester (opposite).....	49	43.37		20	39.64		do	Do.
Chew Hill.....	48	16.99		10	01.68		do	Do.
Church Landing Point.....	39	39.95		31	20.27		do	Do.
Clayton, church.....	39	26.29		05	29.73		do	Do.
Cohansey light-house (old).....	20	21.49		21	36.88		do	Do.
Coopers Point.....	57	15.64		07	42.22		do	Do.
Cove.....	26	13.73		28	18.14		do	Do.
Crab Creek.....	50	39.50		17	39.73		do	Do.
Daretown.....	36	05.20		15	37.20		do	Do.
Davis.....	22	40.55		20	31.34		do	Do.
Dayre.....	21	47.78		20	13.07		do	Do.
Do.....	21	47.65		20	12.97		do	Do.
Deerfield.....	32	32.20		13	24.20		do	Do.
Dividing Creek.....	15	20.22		05	23.72		do	Do.
Dunck Beach.....	20	36.34		22	10.63		do	Do.
Dutch Neck.....	23	24.10		15	13.00		do	Do.
Dyer Cove.....	16	06.54		13	42.42		do	Do.
Eagle Island.....	17	49.26		14	27.10		do	Do.
Eagle Point.....	52	42.34		10	00.69		do	Do.
East Point.....	11	31.62		01	17.70		do	Do.
Egg Island.....	10	25.07		08	05.52		do	Do.
Light-house.....	10	43.82		08	13.22		do	Do.
Point.....	10	26.63		08	08.40		do	Do.
Elder Point.....	12	42.86		02	51.93		do	Do.
Eldridge Hill.....	39	45.30		18	24.30		do	Do.
Ellet.....	38	22.75		23	56.45		do	Do.
Elmer.....	34	57.50		11	12.70		do	Do.
Do.....	22	13.17		09	09.39		do	Do.
Elsinboro.....	32	26.33		32	03.54		do	Do.
Do.....	32	27.48		32	03.46		do	Do.
Elsinboro Point, in old Swedish fort.....	32	24.94		32	03.81		do	Do.
Fairton.....	22	33.37		13	12.26		do	Do.
Do.....	22	13.90		09	09.60		do	Do.
Fairview.....	58	28.13		03	56.89		do	Do.

NEW JERSEY—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	39°-40°			75°-76°				
	°	'	"	°	'	"		
False Egg Point.....	39	12	01.23	75	10	11.92	C. & G. S.....	Final Rept., Vol. 1.
Finn Point.....	36	00.15		33	02.57		do.....	Do.
Do.....	36	01.31		33	05.32		do.....	Do.
Fish club, flagstaff.....	53	16.54		07	43.82		do.....	Do.
Fish cove.....	58	23.87		03	53.17		do.....	Do.
Flax Farm.....	16	36.52		13	13.95		do.....	Do.
Fort Mifflin.....	52	31.67		12	45.28		do.....	Do.
Fortesque.....	14	12.65		10	19.60		do.....	Do.
Do.....	14	07.19		10	16.10		do.....	Do.
Big flagstaff.....	14	15.38		10	14.22		do.....	Do.
Pavilion flagstaff.....	14	12.23		10	19.14		do.....	Do.
Garrison.....	23	36.88		13	22.47		do.....	Do.
Glassboro, white spire.....	42	00.70		06	46.70		do.....	Do.
Gloucester Point.....	53	49.18		07	46.86		do.....	Do.
Greenwich.....	23	27.61		20	41.20		do.....	Do.
Haddonfield.....	52	53.37		02	23.30		do.....	Do.
Do.....	53	59.30		01	45.70		do.....	Do.
Hann.....	25	27.09		15	26.63		do.....	Do.
Harris.....	25	10.11		17	35.77		do.....	Do.
Hawkins.....	25	35.42		20	40.87		do.....	Do.
Heusted.....	22	58.36		18	58.15		do.....	Do.
Horner.....	57	40.85		05	42.31		do.....	Do.
Iona.....	36	10.20		04	38.20		do.....	Do.
Isaac.....	50	47.94		15	42.77		do.....	Do.
Jacob Creek.....	21	40.07		23	38.25		do.....	Do.
Jericho.....	29	19.80		21	50.20		do.....	Do.
Jocelyne.....	18	40.25		08	23.09		do.....	Do.
John Dayre.....	26	23.79		12	46.93		do.....	Do.
Kaighn Point.....	55	45.96		07	52.54		do.....	Do.
Kinsey.....	38	06.31		33	22.14		do.....	Do.
Laurel.....	26	21.44		13	43.04		do.....	Do.
Lippincott.....	43	20.56		18	49.81		do.....	Do.
Mahon River light-house.....	10	19.50		24	02.83		do.....	Do.
Man Island.....	50	22.77		19	27.99		do.....	Do.
Marcus Hook (opposite).....	47	42.17		24	21.57		do.....	Do.
Mathew.....	51	19.64		12	42.73		do.....	Do.
Maurice River light-house.....	11	45.23		01	39.53		do.....	Do.
Maurice River (west).....	19	43.20		02	53.16		do.....	Do.
Merchantville, east spire.....	57	00.60		02	57.00		do.....	Do.
Mickle.....	54	40.31		07	22.47		do.....	Do.
Millville, standpipe.....	24	15.10		02	52.70		do.....	Do.
Morris.....	59	23.70		02	36.51		do.....	Do.
Morris Hill.....	59	24.78		02	36.76		do.....	Do.
Mount Pleasant.....	23	25.17		15	22.30		do.....	Do.
Mulford Landing.....	22	21.10		19	26.00		do.....	Do.
Nan.....	16	40.53		14	46.80		do.....	Do.
Nantuxent.....	16	36.81		14	45.49		do.....	Do.
New.....	24	09.65		26	35.13		do.....	Do.
New Boston.....	31	17.90		17	10.20		do.....	Do.
Newfield.....	32	13.84		00	16.13		do.....	Do.
Ogden.....	22	06.57		15	28.23		do.....	Do.
Oldman Creek.....	47	04.94		25	52.51		do.....	Do.
Oldman Point.....	45	40.44		27	41.32		do.....	Do.
Pine Mount.....	25	03.79		20	15.94		do.....	Do.
Pot.....	29	06.11		31	27.73		do.....	Do.
Port Norris.....	14	36.29		01	17.09		do.....	Do.
Powder Wharf.....	54	13.47		08	03.23		do.....	Do.
Red Bank flagstaff.....	52	20.45		11	20.99		do.....	Do.
Reedy Island light-house.....	30	03.37		34	08.76		do.....	Do.
Reeves.....	39	06.58		23	05.60		do.....	Do.
Robbin.....	44	34.39		20	02.15		do.....	Do.
Roman Catholic Seminary.....	29	43.26		01	37.26		do.....	Do.
Round.....	25	36.85		27	39.52		do.....	Do.
Round Island.....	25	21.99		27	33.14		do.....	Do.
Do.....	25	22.02		27	33.17		do.....	Do.
Do.....	25	27.04		27	36.01		do.....	Do.
Salem:								
Presbyterian church spire.....	34	24.10		27	59.28		do.....	Do.
Episcopal church spire.....	34	28.62		27	57.38		do.....	Do.
Scull.....	43	33.11		20	42.13		do.....	Do.
Do.....	40	59.77		20	52.29		do.....	Do.
Sea Breeze, Warner House flagstaff.....	19	26.71		19	14.83		do.....	Do.
Sheppard.....	22	41.43		21	22.81		do.....	Do.
Ship John light-house.....	18	19.10		22	37.08		do.....	Do.
Sneed.....	27	32.96		31	01.94		do.....	Do.
Stony.....	27	47.42		31	12.55		do.....	Do.
Do.....	28	01.83		31	16.12		do.....	Do.
Stony Point.....	27	33.09		31	09.25		do.....	Do.
Stow.....	22	50.27		24	51.89		do.....	Do.
Stringtown.....	40	13.30		14	18.80		do.....	Do.
Swedesboro, spire Episcopal church.....	45	02.04		18	26.72		do.....	Do.

NEW JERSEY—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	39°-40°	75°-76°		
	° ' "	° ' "		
Thompson Point.....	39 50 34.93	75 18 23.90	C. & G. S.	Final Rept., vol. 1.
Tioga.....	58 45.36	05 14.26	do	Do.
Tomlin.....	13 46.84	00 09.58	do	Do.
Tonkin Island.....	49 14.50	22 00.34	do	Do.
Do.....	48 52.06	22 50.68	do	Do.
Tripod.....	12 36.04	02 43.10	do	Do.
Turkey Point.....	14 59.23	07 41.06	do	Do.
Vineland, church.....	29 10.17	01 16.12	do	Do.
West.....	45 39.83	12 20.01	do	Do.
West Point.....	19 06.31	15 30.23	do	Do.
Wheaton.....	23 29.83	19 25.40	do	Do.
Wood Point.....	57 28.27	05 38.73	do	Do.
Woodbury Creek.....	51 53.13	11 52.75	do	Do.
Woodruff.....	24 49.75	08 47.25	do	Do.
Cape May:	38°-39°	74°-75°		
Old light-house.....	38 55 51.84	74 57 58.50	do	Do.
New light-house.....	55 53.62	57 35.17	do	Do.
Congress Hall.....	55 54.21	55 29.37	do	Do.
Higbee.....	57 17.32	57 51.55	do	Do.
Two-Mile Beach.....	57 29.33	50 59.70	do	Do.
Weeks Landing.....	58 58.79	52 69.20	do	Do.

PENNSYLVANIA.

	42°-43°	79°-80°		
	° ' "	° ' "		
Harbor Creek, Erie County.....	42 12 03.70	79 56 35.00	L. S.	Final Rept.
Erie.....	42°-43°	80°-81°		
Beacon light-house No. 2.....	42 09 11.90	80 04 40.20	do	Do.
Light-house.....	09 17.49	04 46.95	do	Do.
Standpipe of waterworks.....	07 53.30	05 50.80	do	Do.
Miles Grove.....	03 38.80	21 49.90	do	Do.
Presque Isle light-house.....	09 56.70	06 56.70	do	Do.
Bald, Lackawanna County.....	41°-42°	75°-76°		
Bald, 3, Clinton County.....	41 25 41.24	75 45 04.92	C. & G. S.	Bull. 122.
Bellevue, church.....	37 48.30	25 37.60	G. S.	Do.
Elk.....	24 03.54	41 14.23	C. & G. S.	
Farview Tower.....	42 53.84	33 39.44	do	Do.
Glen Summit.....	35 35.36	25 55.60	G. S.	
Hyde Park, church.....	08 53.00	50 30.80	do	Do.
Jermyn.....	24 50.78	41 03.36	C. & G. S.	
Miller.....	32 29.01	34 28.58	G. S.	Do.
Moosic.....	29 20.95	59 08.86	do	Do.
Nescopeck, 1.....	27 20.65	29 44.07	C. & G. S.	
No. 10.....	05 04.29	56 27.47	G. S.	Do.
Olyphant, church.....	24 38.74	34 20.59	C. & G. S.	
Panther.....	28 22.88	36 23.74	do	
Penobscot.....	14 09.03	38 10.92	do	
Petersburg, church.....	10 57.14	52 21.83	do	Do.
Pimple Hill.....	24 38.04	38 30.25	do	
Pimple, tree.....	01 36.33	30 18.31	do	
Providence, church.....	01 36.79	30 20.48	do	
Salem.....	26 27.20	39 29.80	do	
Scranton, court house.....	33 01.48	27 26.00	G. S.	Do.
Wilkesbarre, church.....	24 28.58	39 46.62	C. & G. S.	
Woodside, church.....	14 31.77	53 03.59	do	
Wyoming.....	00 37.47	54 27.42	do	
	20 54.16	50 39.69	G. S.	Do.
Athens.....	41°-42°	76°-77°		
Knob.....	41 57 31.92	76 36 58.96	S. S.	Rept. '87.
Kocher.....	05 44.16	20 46.41	C. & G. S.	Bull. 122.
Litchfield.....	21 28.05	07 04.75	G. S.	Do.
Nanticoke, church.....	59 22.88	25 48.22	S. S.	Rept. '87.
Nescopeck, 2.....	12 16.01	00 01.90	C. & G. S.	Do.
North.....	02 13.91	05 03.40	G. S.	Bull. 122.
Ricketts.....	19 09.97	33 17.13	do	Do.
Shickshinny.....	18 31.13	18 34.67	C. & G. S.	Do.
Warren.....	09 59.40	09 08.77	do	Do.
	59 23.38	10 43.82	S. S.	Rept. '87.
Bly.....	41°-42°	77°-78°		
Friars Head.....	41 54 36.02	77 00 40.05	do	Do.
Harrison.....	58 15.90	43 41.40	C. & G. S.	Do.
	54 59.04	41 51.83	S. S.	Do.

PENNSYLVANIA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	41°-42°			80°-81°				
	°	'	"	°	'	"		
Edinboro.....	41	52	28.41	80	10	46.88	L. S.....	Final Rept.
State Line between Pennsylvania and Ohio.....		59	17.70		29	08.20	do.....	Do.
	40°-41°			74°-75°				
Attleboro, academy cupola.....	40	10	53.56	74	55	17.83	do.....	
Belmont.....		08	22.41		56	48.39	do.....	
Briggs.....		12	25.09		53	37.11	do.....	
Bristol, Kenzey Hotel, cupola, called Posten's Hotel in 1877.....		05	40.61		51	22.92	do.....	
Centerville.....		09	44.69		50	18.30	do.....	
China College.....		04	48.82		54	03.01	do.....	
Delanco.....		02	46.15		57	46.20	do.....	
Church spire.....		02	58.11		57	25.15	do.....	
Falsington.....		11	53.52		48	44.20	do.....	
Fisher.....		02	37.01		59	15.71	do.....	
Martingale.....		14	37.99		56	57.15	do.....	Bull. 122.
Newtown.....		15	03.41		55	13.93	do.....	
Oxford.....		10	24.34		53	41.71	do.....	
Partridge.....		03	16.62		58	33.33	do.....	
Pleasantville.....		09	51.19		59	04.35	do.....	
Stackhouse.....		09	59.18		55	01.55	do.....	
Thomas.....		13	14.82		58	19.69	do.....	
Turkey Hill.....		09	52.02		46	29.37	do.....	
Watson.....		12	14.66		55	28.20	do.....	
Wynkop.....		12	59.80		58	45.27	do.....	
	40°-41°			75°-76°				
Bethlehem, Reformed church.....	40	37	16.77	75	22	33.44	do.....	
Bake Oven.....		44	54.11		44	02.22	do.....	Do.
Big Rock.....		33	53.73		26	16.42	do.....	Do.
Black Spot.....		20	51.15		54	09.86	do.....	Do.
Tower.....		20	50.32		54	09.73	do.....	Do.
Bridesburg.....		00	02.75		03	42.51	do.....	
Arsenal flagstaff (1842).....		00	29.24		03	59.66	do.....	
Foundry.....		00	13.16		03	46.87	do.....	
Church.....		00	08.61		03	58.95	do.....	
Arsenal flagstaff (1878).....		00	29.06		04	00.71	do.....	
Cherry Tree.....		02	44.04		07	20.98	do.....	
Chestnut Hill, flagstaff.....		04	35.93		12	27.57	do.....	
Churchville.....		11	36.98		01	18.43	do.....	
Clapier.....		01	12.21		10	07.82	do.....	
Clark.....		00	15.43		14	17.40	do.....	
Collegeville, spire.....		02	44.22		01	01.96	do.....	
Diston:								
Flagstaff.....		01	07.15		02	14.71	do.....	
Chimney.....		01	05.93		02	23.04	do.....	
Dutch Settlement, Union church.....		03	49.00		04	43.00	S. S.....	Rept. '83.
Fancy Hill, Berks County.....		19	24.89		42	52.13	C. & G. S.....	Bull. 122.
Frankford:								
Pumping station.....		00	48.25		02	51.02	do.....	
Chimney.....		00	50.61		02	51.83	do.....	
Catholic church spire.....		00	42.48		05	25.03	do.....	
French.....		02	06.52		08	36.15	do.....	
George Knowles.....		01	17.67		01	53.53	do.....	
Germantown:								
Spire.....		01	02.16		10	48.10	do.....	
Church.....		01	55.66		10	29.23	do.....	
Haycock.....		29	18.96		13	10.34	do.....	
Knob.....		53	44.07		49	45.48	do.....	Do.
Kreutzer.....		37	15.58		31	42.05	do.....	Do.
Lennig:								
Square chimney.....		00	15.74		03	36.57	do.....	
Round chimney.....		00	21.34		03	40.29	do.....	
Lone Tree.....		48	10.50		52	43.52	do.....	
Long.....		21	28.35		42	03.79	do.....	Do.
Miles.....		11	16.96		03	13.18	do.....	
Pennypack.....		02	11.35		00	00.32	do.....	
Philadelphia:								
House of Correction.....		01	30.72		00	52.76	do.....	
Flagstaff.....		01	43.63		00	58.73	do.....	
Chimney.....		01	48.94		01	04.44	do.....	
St. Vincent's School cupola.....		01	21.10		01	53.09	do.....	
McKean's tower.....		01	11.80		10	07.75	do.....	
Potter's Mill, cupola.....		00	21.18		07	54.82	do.....	
Mr. George's house, flag-pole on cupola.....		00	19.10		14	16.96	do.....	
Richard's house, cupola.....		00	42.13		10	46.87	do.....	
Port Clinton.....		36	15.05		59	27.82	do.....	Do.
Rockwell house.....		00	14.72		12	23.15	do.....	
Smith Gap.....		49	21.79		25	21.91	do.....	

PENNSYLVANIA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	40°-41°			75°-76°				
	°	'	"	°	'	"		
South, cupola on house.....	40	01	26.18	75	02	24.01	C. & G. S.	
South base.....		02	04.86		08	36.65	do	
Stub, center line, Broad street, Philadelphia.		02	04.81		08	45.58	do	
Summit Hill:								
Clock tower of school.....		49	35.58		52	27.34	do	
Presbyterian church spire (sharp).....		49	32.57		52	23.99	do	
Catholic church spire (blunt).....		49	27.84		52	51.57	do	
Switchback, chimney.....		49	31.95		51	27.53	do	
Tacony:								
Water tower.....		01	42.92		02	41.24	do	
Methodist church spire.....		01	28.92		02	34.55	do	
Ten Mile Point.....		01	26.06		01	04.88	do	
Topton.....		28	37.49		40	58.25	do	Bull. 122.
Van Kirk.....		00	33.06		03	21.12	do	
Vancleve.....		09	10.67		03	01.80	do	
Washington.....		01	07.64		02	11.75	do	
Willowgrove.....		08	31.94		06	22.28	do	
	40°-41°			76°-77°				
Barry.....	40	44	15.39	76	25	42.12	do	Do.
Bears Head.....		51	01.35		04	47.65	do	Do.
Beartown.....		04	51.95		00	48.49	do	
Berries.....		31	37.24		55	54.36	G. S.	Do.
Big Lick.....		35	42.95		37	03.20	do	Do.
Buck.....		57	00.00		14	45.22	do	Do.
Catawissa.....		56	20.28		25	33.10	do	Do.
Dauphin.....		21	59.05		54	32.71	C. & G. S.	Do.
Frackville.....		46	09.67		15	28.06	G. S.	Do.
Governor Dick.....		14	46.77		27	21.11	C. & G. S.	
Lancaster, prison tower.....		02	24.58		17	33.52	do	
Little Mahanoy.....		44	35.47		49	56.57	G. S.	Do.
Mahanoy.....		45	45.95		43	07.20	do	Do.
Mahanoy, 1.....		45	20.08		35	24.24	do	Do.
Mahanoy, 2.....		45	28.87		37	07.88	do	Do.
Mahanoy, 3.....		45	20.08		35	24.24	do	Do.
Montour.....		56	29.82		49	00.42	C. & G. S.	Do.
Nescopeck, 3.....		59	08.98		18	46.16	G. S.	Do.
Round Top.....		06	13.24		55	34.14	C. & G. S.	
Swatara Gap.....		28	15.40		32	23.52	do	
White Horse.....		30	55.19		17	33.95	do	Do.
Womelsdorf.....		19	28.25		11	44.69	do	Do.
Woodruff.....		52	45.62		34	33.03	G. S.	Do.
	39°-40°			75°-76°				
Alburger.....	39	52	06.36	75	17	01.86	C. & G. S.	
Belmont Reservoir.....		59	09.33		13	08.73	do	
Bethel.....		50	46.23		29	25.34	do	
Black.....		52	14.19		13	08.55	do	
Bristol.....		59	22.64		04	13.22	do	
Blackhorse.....		54	48.45		25	26.01	do	
Buist.....		55	00.77		13	36.05	do	
Canal.....		56	43.51		08	19.31	do	
Cannonball.....		53	22.52		13	29.37	do	
Chester:								
Brickley's flagstaff.....		50	51.75		21	35.07	do	
Catholic cathedral.....		51	05.43		21	39.13	do	
Catholic church.....		51	05.25		21	38.90	do	
City hall.....		50	52.20		21	36.86	do	
Coyne's Chemical Works chimney.		50	37.28		21	26.76	do	
Crozier's Seminary.....		51	21.58		22	16.78	do	
Eureka Steel Works chimney.....		50	28.18		22	36.53	do	
Folson's sugar refinery chimney.....		50	39.46		21	23.78	do	
Irving & Leiper, cotton mill chimney.		50	31.38		21	48.70	do	
Morton & Black—								
Cupola.....		51	03.29		21	06.36	do	
Sawmill chimney.....		51	03.74		21	05.19	do	
Octagonal chimney.....		50	52.37		21	48.53	do	
Presbyterian church.....		50	53.10		21	30.30	do	
Roach—								
House.....		50	51.75		22	18.62	do	
Office.....		50	26.68		22	04.66	do	
Sharpless Dyewood Works.....		50	12.00		22	19.34	do	
Simpson, paint works, chimney.....		51	11.46		20	32.54	do	
Yarnall, mill chimney.....		50	02.18		22	38.04	do	
Coliseum, flagstaff.....		56	52.54		09	52.11	do	
Crothers.....		55	19.82		13	18.93	do	
Crum Creek, near mouth, engineer's signal 5.		51	28.90		19	30.74	do	
Davis.....		55	40.01		18	15.63	do	

PENNSYLVANIA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	39°-40°			75°-76°				
	°	'	"	°	'	"		
Delaware Lead Works	39	56	36.71	75	08	13.46	C. & G. S.	
Devine's mill (near Philadelphia) cupola.		56	48.73		10	37.36	do	
East League Island		53	14.88		09	58.07	do	
Eastwicks tower, vicinity of Phila- delphia.		55	51.97		12	46.09	do	
Engineer signal, on wharf at Fort Mifflin.		52	28.13		12	40.99	do	
Factory, near Philadelphia		58	40.60		08	43.25	do	
Five Mile Point		59	04.44		04	29.83	do	
Five Mile Point, 2, Harrison Wharf		59	08.49		04	19.51	do	
Fort Mifflin:								
Flagstaff (1843)		52	31.64		12	45.33	do	
Light-house (1878-79)		52	14.49		12	27.05	do	
Fuller's tower		52	18.10		19	58.60	do	
General Jeffries, tower		52	43.57		19	25.23	do	
George Hill, elevator		59	02.92		13	29.03	do	
Gloucester Ferry		53	43.25		09	50.17	do	
Glue Chimney		58	55.50		05	57.97	do	
Gray's Ferry		56	27.22		12	28.70	do	
Hog Island		52	00.87		14	19.59	do	
Jenks		59	52.82		03	53.26	do	
Kensington:								
First Presbyterian church		58	12.69		07	48.40	do	
Iron works, black derrick		57	43.22		08	02.17	do	
Water pipe		58	09.66		07	24.65	do	
Lamoken		50	40.01		22	33.06	do	
Lazaretto		51	37.03		18	11.65	do	
Cupola		51	38.84		18	01.69	do	
Flagstaff (1849-1879)		51	25.97		18	02.14	do	
Lazaretto, 2		51	36.27		18	08.21	do	
League Island		53	09.09		11	28.62	do	
Leiperville (1843-1879)		52	25.62		19	34.94	do	
Lemov Hill		58	17.53		11	21.22	do	
Logan		54	03.10		08	05.58	do	
Londonderry		51	50.51		52	50.44	do	
Lukens		51	52.49		17	57.85	do	
Maddock		52	16.99		20	00.56	do	
Maiden Island, engineer signal 3		51	21.63		15	19.60	do	
Manderson, north chimney of house		57	54.14		07	06.26	do	
Marcus Hook		48	41.39		24	44.34	do	
Baptist church		48	49.14		24	47.78	do	
Episcopal church		48	52.65		24	41.65	do	
Pioneer Iron Works chimney		48	48.86		24	38.40	do	
Tenderthorpe Club House		48	38.71		24	59.52	do	
Missimer		44	59.07		48	03.78	do	
Monument Cemetery, spire		58	54.26		09	28.10	do	
Mount Hope		52	27.55		26	28.03	do	
Movies, 2 (1884)		59	23.70		02	36.51	do	
North League Island		53	14.84		09	57.83	do	
Old Bank		54	35.43		13	34.05	do	
Old Oak Tree		54	04.17		13	00.77	do	
One		54	43.87		08	10.90	do	
Paschall		54	49.36		14	30.05	do	
Pennsylvania Military Academy		51	42.04		21	20.40	do	
Penrose Ferry, lantern of draw		53	43.68		12	33.42	do	
Philadelphia:								
Aldine Hotel		57	06.48		10	22.58	do	
Almshouse, gray chimney		56	53.61		11	44.82	do	
Arch Street church		57	12.49		09	25.86	do	
Arch Street Hotel, corner		57	06.10		08	27.73	do	
Arch Street Wharf, house		57	05.30		08	23.86	do	
Baptist church		57	16.01		11	40.77	do	
Baugh's black derrick		55	28.26		08	20.63	do	
Beck's shot tower		57	23.39		10	31.61	do	
Boiler house chimney		54	50.63		08	05.08	do	
Boston Steamship Co. (pier 20 S. W.).		56	34.81		08	30.77	do	
Brown street, river market house		57	41.25		08	13.37	do	
Burd's Orphan Asylum, cross on lower cupola.		57	43.59		15	05.08	do	
Burnt Factory, south chimney (old lazaretto).		53	19.79		12	23.61	do	
Center line of Broad street on tower of city hall.		57	10.08		09	49.86	do	
Central High School Observatory		57	47.20		09	40.81	do	
City hall—								
Center line of Broad street		57	06.85		09	50.53	do	
Main tower station (near northwest corner).		57	10.05		09	50.17	do	
Christ church		57	02.67		08	39.73	do	

PENNSYLVANIA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	39°-40°			75°-76°				
	°	'	"	°	'	"		
Philadelphia—Continued.								
Cramp's shears	39	58	13.52	75	07	02.39	C. & G. S.	
Delaware avenue market house		56	39.78		08	34.15	do	
Fire plug, Fifty-third street		57	36.48		13	37.52	do	
Franklin Sugar Refinery, south turret.		56	22.32		08	34.24	do	
Gas tower (west tower near river)		55	16.90		12	09.32	do	
Girard College, on roof of		58	26.60		10	13.54	do	
Girard Point elevator		53	40.32		11	54.31	do	
Jaynestower		56	54.55		08	45.48	do	
Levee, 1		53	54.41		08	27.87	do	
Levee, 2		53	41.23		09	06.73	do	
Lombard street wharf		56	29.01		08	30.48	do	
Market street, northeast corner of wharf.		56	56.56		08	26.39	do	
Market street and Delaware avenue.		56	59.02		08	29.70	do	
Moro Philips flagstaff (pier 35 S. W.).		56	16.70		08	29.92	do	
Navy-yard flagstaff		53	16.26		10	30.46	do	
Navy-yard signal, center of Broad street.		53	29.78		10	37.76	do	
Neafie and Levy's shears		57	59.55		07	35.76	do	
New high school		57	47.19		09	40.81	do	
Noble street wharf		57	30.70		08	12.26	do	
Old high school, observatory		57	05.95		09	45.20	do	
Old navy-yard shears		55	52.00		08	29.41	do	
Otis street, north corner of wharf.		58	05.41		07	20.93	do	
Park elevator		58	17.54		11	21.31	do	
Philadelphia and Reading (pier 14 S. W.).		56	42.44		08	29.56	do	
Philadelphia and Reading R. R. wharf.		58	21.83		06	41.75	do	
Post-office		57	02.19		09	21.48	do	
Presbyterian Home		55	59.82		13	37.91	do	
Race Street Wharf		57	19.97		08	21.68	do	
Ridgeway House—								
Corner		56	59.01		08	29.71	do	
Flagstaff		56	59.25		08	29.76	do	
Roman Catholic cathedral		57	26.71		10	07.66	do	
St. Bonifacius church		58	54.60		08	08.48	do	
St. John's church spire		58	11.87		09	43.14	do	
St. Paul's church		57	47.59		08	31.12	do	
St. Philip's Literary Institute, octagonal spire on Queen street, near Sixth.		56	16.35		09	12.04	do	
St. Peter's church		56	35.34		08	53.38	do	
Salt works chimney		54	47.95		08	19.75	do	
Salt company's wharf		54	51.85		07	59.35	do	
Screw dock		57	49.99		07	56.06	do	
Shackamaxon street (pier 49, wharfage signpost).		57	50.12		07	51.18	do	
Ship house, south gable		53	14.68		10	38.81	do	
Sparks shot tower		56	05.23		08	48.00	do	
State House, cupola		56	55.64		09	09.41	do	
University of Pennsylvania, east tower.		57	05.11		11	37.23	do	
Vine street ferry flagstaff		57	18.99		08	22.74	do	
West Arch Street church		57	17.57		10	10.93	do	
West Philadelphia Hall, flagstaff		57	22.25		11	46.61	do	
Pike		59	05.80		04	45.48	do	
Point Breeze		54	31.71		12	18.56	do	
Flagstaff		54	11.11		11	42.39	do	
Richmond		58	18.71		06	59.44	do	
Ridley Creek		51	11.90		20	24.61	do	
Sanderson		50	12.92		23	50.97	do	
Schuylkill		53	35.90		11	42.32	do	
Schuylkill Range beacon, front (1878).		53	20.11		11	38.25	do	
Schuylkill Range beacon, rear (1878-79).		53	27.22		11	34.95	do	
Schuylkill arsenal, flagstaff on cupola.		56	26.33		11	20.16	do	
Scott		55	59.19		08	27.31	do	
Serrill		52	58.19		14	49.91	do	
Sinickson		54	29.07		07	56.97	do	
Smith Island		56	21.05		08	15.82	do	
Flagstaff		56	48.66		08	17.27	do	
Smith Island, 2		56	47.97		08	09.75	do	
South Chester, schoolhouse		50	39.06		23	05.62	do	
South League Island, 2		53	09.13		11	28.68	do	
South League Island, Die River		53	09.12		11	28.66	do	
Stewart		52	25.01		19	34.57	do	
Strickersville		43	55.38		47	27.54	do	

PENNSYLVANIA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	39°-40°			75°-76°				
	°	'	"	°	'	"		
Three.....	39	53	47.69	75	08	47.38	C. & G. S.	
Thurlow.....		49	41.25		23	11.90	do	
Tinnicum.....		51	42.32		16	03.89	do	
Tioga, 2 (1884).....		58	45.36		05	14.26	do	
Tonkins Island west.....		48	52.09		22	50.64	do	
Trainer's (E.) mill, 3.....		49	37.65		24	03.06	do	
Trainer's (E.) tower.....		49	54.54		24	34.19	do	
West Philadelphia, Presbyterian hos- pital.....		57	30.81		11	58.50	do	
Windmill Island, 1.....		56	34.37		08	18.95	do	
Windmill Island, 2.....		56	25.88		08	14.40	do	
Windmill Island: South point post.....		56	18.84		08	15.10	do	
Chimney.....		56	34.34		08	14.22	do	
Yard.....		58	24.80		23	13.79	do	
	39°-40°			76°-77°				
	°	'	"	°	'	"		
Pulpit Rock.....	39	51	26.77	76	56	53.27	do	
Rawlinsville.....		53	09.54		15	58.37	do	
Winterstown.....		49	32.07		36	09.30	do	

DELAWARE.

	39°-40°			75°-76°				
	°	'	"	°	'	"		
Buck, 2.....	39	32	26.78	75	43	55.18	C. & G. S.	
Grandview.....		42	42.66		42	22.72	do	
Iron Hill.....		38	20.48		45	07.67	do	
Meetinghouse Hill.....		42	46.28		42	40.12	do	
Naaman Creek.....		48	05.47		26	32.96	do	
Naaman Creek, 2.....		48	17.61		26	01.06	do	
Taggart.....		47	29.91		27	37.10	do	

MARYLAND.

	39°-40°			75°-76°				
	°	'	"	°	'	"		
Gray Hill.....	39	36	47.69	75	47	51.69	C. & G. S.	
	39°-40°			76°-77°				
	°	'	"	°	'	"		
Abingdon, cupola.....	39	27	41.50	76	16	42.21	do	
Baltimore Cemetery, brown spire.....		18	45.23		34	52.00	do	
Baltimore: City Hall cupola.....		17	27.12		36	39.68	do	
Fort Avenue— East base.....		15	56.51		35	05.60	do	
West base.....		16	19.53		36	11.32	do	
Grace church spire, Methodist.....		17	52.00		38	14.42	do	
Hospital (1863).....		17	50.35		35	31.39	do	
Holy Cross, German Catholic church spire.....		16	34.28		36	41.33	do	
Johns Hopkins, hospital cupola.....		17	50.25		36	36.91	do	
Sacred Heart Catholic church spire.....		17	04.89		34	08.38	do	
St. James church spire.....		18	04.54		36	07.59	do	
St. John's church, brown spire.....		19	31.52		36	33.24	do	
Washington Monument, head of statue.....		17	51.07		36	57.34	do	
Bay View Asylum, vane.....		17	23.33		33	06.73	do	
Buchanan.....		15	29.85		32	39.66	do	
Canton, cupola Chipman's chair fac- tory.....		16	45.92		34	44.71	do	
Chase, flagstaff on B. & O. coffee warehouse on Chase's wharf.....		16	44.89		35	47.12	do	
Clifton, cupola vane.....		19	14.99		35	15.05	do	
Clinton.....		15	44.52		34	06.91	do	
Colgate.....		15	25.23		32	30.74	do	
De Sales, cross on cupola Mt. De Sales Carmelite convent.....		17	06.57		43	19.86	do	
Druid, small spire on cupola of Druid Hill Park House.....		19	24.48		38	50.44	do	
Elevator B, belfry.....		16	11.02		35	02.05	do	
Federal (1886).....		16	48.96		36	30.17	do	
Ferry.....		15	33.04		36	44.83	do	
Finlay, on Cubb Hill.....		24	28.00		31	28.51	do	
Fishing Point.....		13	50.75		33	49.13	do	

MARYLAND—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	39°-40°			76°-77°				
	°	'	"	°	'	"		
Foley Wharf.....	39	15	43.87	76	34	20.55	C. & G. S.	
Fort Avenue:								
East base.....	15	56.52		35	05.60		do	
West base.....	16	19.53		36	11.32		do	
Fort Carroll light-house (1866).....	12	52.95		31	09.04		do	
Fort Marshall, flagstaff (1863).....	17	07.46		34	06.02		do	
Fort McHenry, most easterly salient of.....	15	47.38		34	45.86		do	
Fort McHenry (1842-1886).....	15	47.47		34	46.88		do	
Gail and Ax, vane of tobacco factory.....	16	59.36		36	51.22		do	
Garritty.....	15	01.07		31	36.44		do	
Gas.....	16	32.86		34	11.99		do	
Green cupola, west end B. & O. piers 8 and 9.....	16	21.53		35	16.00		do	
Green Mount Cemetery, brown spire.....	18	25.93		36	27.82		do	
Guano factory cupola, a mill in 1866.....	16	43.66		36	32.94		do	
Hawkins Point light-house (1869).....	12	28.42		31	58.38		do	
Hawkins Point, 2 (1866).....	12	35.24		31	59.89		do	
Hawkins Point, 3 (1866).....	12	34.89		31	57.96		do	
House of Refuge, apex of taller turret.....	15	51.12		43	25.70		do	
Knabe piano factory, cupola vane.....	16	38.69		37	21.17		do	
Leading.....	13	00.74		33	00.43		do	
Leading Point light-house (1869).....	12	49.33		33	07.80		do	
Lawrence.....	16	19.41		36	06.71		do	
Lazaretto Point light-house (1843-1886).....	15	45.66		34	17.96		do	
Linsted.....	05	21.73		29	08.80		do	
Lynch, in water area.....	15	09.28		26	52.34		do	
McDonald, house cupola.....	20	19.09		36	47.34		do	
Moale.....	15	52.96		37	13.30		do	
Mount Alto.....	19	06.20		40	33.61		do	
No. 1.....	14	46.75		36	07.32		do	
Notre Dame Convent, lightning rod.....	21	05.13		37	17.50		do	
Oak.....	16	18.99		40	21.11		do	
Osborne River.....	27	54.94		16	52.84		do	
Pious Hill.....	20	15.02		33	40.71		do	
Principio.....	35	36.69		00	16.41		do	
Rock Point, 2 (1866).....	10	02.02		28	43.01		do	
Rosanne.....	17	30.76		43	04.56		do	
Sallers Point, 2 (1866).....	13	39.96		30	49.19		do	
Sallers Point, 3 (1866).....	13	39.37		30	48.26		do	
Sallers Shore.....	13	54.22		31	02.42		do	
Sand Hill.....	14	51.35		35	01.61		do	
Shyrock's Wharf, flagstaff.....	16	42.12		35	50.02		do	
Small white spire.....	16	18.14		39	27.86		do	
Soper.....	05	11.84		57	00.72		do	
Spring Gardens.....	16	24.49		37	38.20		do	
Stabler.....	07	17.71		59	06.49		do	
Taylor.....	16	48.54		35	58.11		do	
Tyson.....	14	31.75		34	01.80		do	
United States bonded warehouse, flagstaff.....	16	47.45		35	23.69		do	
Webb.....	05	26.05		40	32.16		do	
Woodall.....	16	15.22		35	53.25		do	
Woodlawn House, apex of roof.....	19	38.43		37	53.71		do	
	39°-40°			77°-78°				
Camp Hill.....	39	04	32.46	77	18	38.80	do	
Catoctin, near Frederick.....	20	43.89		31	12.35		do	
Fairview.....	39	18.10		58	10.90		do	
Frederick:								
Brown spire, dark top.....	24	55.07		24	46.04		do	
Lutheran church—								
East spire.....	24	55.27		24	34.10		do	
West spire.....	24	55.33		24	34.78		do	
Catholic church spire.....	24	56.97		24	28.05		do	
High Knob, near Frederick.....	27	42.24		29	44.20		do	
Iron Stone Ridge.....	10	52.64		26	29.75		do	
Jones (J. N.), red barn, south gable.....	11	38.43		26	16.60		do	
Maryland Heights, near Frederick.....	20	27.69		42	59.91		do	Bull. 122
Offut's house, stone.....	00	25.98		11	14.80		do	
Oxley Hill.....	10	24.14		28	58.22		do	
Poolesville.....	08	16.22		25	11.64		do	
Town hall, flagstaff on south gable.....	08	38.91		25	00.75		do	
Rockville, white spire.....	04	54.41		08	43.03		do	
Scholl Hill.....	13	37.17		25	03.57		do	
Sparrow Point, 2 (1866).....	12	41.32		29	26.26		do	
Sugarloaf.....	15	44.54		23	36.88		do	Do.
White house with wooden wing, northeast chimney.....	12	17.00		27	14.50		do	
	39°-40°			78°-79°				
Sleepy Creek Mountain.....	39	37	12.00	78	07	03.30	do	

MARYLAND—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	39°-40° ° ' "	79°-80° ° ' "		
Fairfax Stone.....	39 43 18.00	79 28 56.60	C. & G. S.....	
	38°-39° ° ' "	76°-77° ° ' "		
Addison.....	38 49 30.91	76 58 44.43	do.....	
Annapolis.....	58 53.50	29 00.00	do.....	
Bladensburg church, east apex.....	56 26.09	56 27.31	do.....	
Brick house, cupola.....	58 42.67	57 33.84	do.....	
Hatton.....	42 58.51	59 15.01	do.....	
Hill.....	53 54.91	52 49.76	do.....	
Magruder.....	54 36.56	55 45.23	do.....	
Maryland Agricultural College.....	59 00.88	56 37.88	do.....	
Marriott.....	52 26.98	36 37.11	do.....	
Painted house, south apex.....	56 15.70	56 05.40	do.....	
Reform school.....	55 31.25	57 34.37	do.....	
Riggs, lightning rod on barn cupola.....	58 12.96	58 27.55	do.....	
Snyder, house gable.....	57 43.81	57 21.73	do.....	
Stearner, lightning rod on east chimney.....	52 27.38	55 35.09	do.....	
Wright.....	54 12.13	54 34.04	do.....	
Yellow mill, south apex.....	56 31.27	56 06.12	do.....	
Yellow roof, white cupola.....	56 46.74	56 33.35	do.....	
Yoe (Wm.), chimney.....	50 17.21	57 53.52	do.....	
	38°-39° ° ' "	77°-78° ° ' "		
Blair's flagstaff.....	38 59 29.55	77 01 57.16	do.....	
Briscoe, Potomac River.....	40 54.56	06 21.55	do.....	
Bryant Point, Potomac River.....	41 44.06	04 06.93	do.....	
Carroll, lightning rod.....	58 43.99	00 15.58	do.....	
Countsman, house chimney.....	57 55.55	04 58.65	do.....	
Ferry Point.....	48 20.55	01 18.39	do.....	
Potomac River.....	41 49.85	06 18.33	do.....	
Fort Washington:				
Signal.....	42 45.43	02 11.14	do.....	
Flagstaff.....	42 40.34	02 06.22	do.....	
Glymont pavilion, Potomac River.....	36 36.59	08 23.75	do.....	
Gut Landing, Potomac river.....	39 50.74	06 57.60	do.....	
Indian Head, Potomac River.....	35 57.41	11 02.20	do.....	
Marshall Point, Potomac River.....	41 09.49	06 01.28	do.....	
Mockley Point, Potomac River.....	42 07.52	02 45.41	do.....	
North Indian Head, Potomac River.....	36 24.02	10 12.79	do.....	
Oxon Hill.....	47 58.52	00 23.69	do.....	
Pamunkey Creek.....	38 04.12	06 39.74	do.....	
Port Tobacco court-house, cupola.....	30 40.77	01 14.18	do.....	
Pye's Wharf, Potomac River.....	36 41.87	08 15.33	do.....	
Rosier Bluff, Potomac River.....	46 20.32	01 51.15	do.....	
Rozier (C.), west gable of house.....	46 31.47	01 08.63	do.....	
Simmons.....	57 07.74	05 53.41	do.....	
Stevenson, Potomac River.....	40 16.03	06 54.05	do.....	
Stump Neck, Potomac River.....	33 15.66	13 29.60	do.....	
Sumner.....	57 18.77	07 30.77	do.....	
White Stone Point, Potomac River.....	40 34.37	07 48.85	do.....	

DISTRICT OF COLUMBIA.

	38°-39° ° ' "	76°-77° ° ' "		
Fort Dupont, flagstaff.....	38 52 22.40	76 56 26.10	C. & G. S.....	
	38°-39° ° ' "	77°-78° ° ' "		
Apex Washington Monument.....	38 53 22.02	77 02 07.78	do.....	
Capitol, head of statue.....	53 23.25	00 33.55	do.....	
Causten.....	55 35.29	04 23.81	do.....	
Georgetown College, observatory.....	54 29.94	04 39.05	do.....	
Insane Asylum.....	51 17.18	00 00.92	do.....	
Kengley's house, lightning rod on southeast chimney.....	55 34.56	04 26.12	do.....	
Soldiers' Home.....	56 29.85	00 40.48	do.....	
Wayland Seminary.....	55 17.33	02 08.53	do.....	
Naval Observatory, pole on dome.....	53 42.25	03 06.10	do.....	
Station east of dome.....	53 42.31	03 05.81	do.....	

VIRGINIA.

	39°-40° ° ' "	77°-78° ° ' "		
Distant lone tree.....	39 04 49.60	77 39 00.20	C. & G. S.....	
Leesburg.....	07 45.62	35 06.16	do.....	
Maryland Heights.....	20 27.69	42 59.91	do.....	
Maryland Heights (S.).....	20 09.97	43 09.14	do.....	

VIRGINIA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	39°-40°	77°-78°		
	° / "	° / "		
Old Pine Tree Hill.....	39 11 31.23	77 34 20.62	C. & G. S.....	
Whitehouse, chimney on northeast gable.	11 08.90	33 19.10	do.....	
	39°-40°	78°-79°		
Capon Mountain.....	39 08 33.30	78 26 06.40	do.....	Bull. 122,
Lockhart.....	14 12.60	19 17.00	do.....	
Locks.....	26 27.20	11 33.40	do.....	
Rock Enon.....	10 39.30	23 23.90	do.....	
Shockey.....	23 25.80	13 47.50	do.....	
Alexandria:	38°-39°	77°-78°		
Baptist church.....	38 48 23.25	77 02 40.58	do.....	
Christ church.....	48 22.64	02 52.37	do.....	
High School.....	49 27.91	05 40.05	do.....	
Northern coal wharf.....	48 51.11	02 11.94	do.....	
Hotel tower.....	48 19.10	02 32.65	do.....	
Theological Seminary, near, new spire cross.	49 13.53	05 31.33	do.....	
Market House cupola.....	48 19.57	02 36.74	do.....	
Pioneer Mills chimney.....	48 05.96	02 24.75	do.....	
Machine shop, brown cupola.....	48 37.15	02 44.84	do.....	
St. Mary's church.....	48 06.70	02 39.27	do.....	
Arlington, flagstaff in front of mansion house.	52 52.10	04 21.10	do.....	
Arlington House, east apex.....	52 52.15	04 21.89	do.....	
Big Cobbler Mountain.....	50 21.00	57 11.00	do.....	
Bull Run.....	52 53.58	42 12.61	do.....	Do.
Cockpit Point, Potomac River.....	33 22.77	15 46.45	do.....	
Culpeper Court-house, flag.....	28 25.58	59 51.27	do.....	
Dangerfield.....	49 45.05	02 19.44	do.....	
Ellsworth.....	48 30.02	04 09.94	do.....	
Erin.....	46 48.60	05 54.50	do.....	
Falls Church.....	52 52.39	10 13.15	do.....	
Fredericksburg, Episcopal church spire.	18 09.57	27 35.33	do.....	
Fort Myer, flagstaff.....	53 07.75	04 39.60	do.....	
Fowle, house cupola.....	47 47.26	05 48.54	do.....	
Gillingham, house chimney.....	46 37.44	04 56.81	do.....	
Gravelly.....	52 00.93	02 12.47	do.....	
Gunston Cove, Potomac River.....	39 20.07	08 39.11	do.....	
Hallowing Point, Potomac River.....	38 05.56	07 51.72	do.....	
Hall, house cupola.....	54 19.89	07 44.82	do.....	
Hamersley.....	45 28.66	04 09.49	do.....	
Hospital, cupola.....	52 03.81	04 07.52	do.....	
Hell Hole Point, Potomac River.....	46 00.70	02 29.01	do.....	
Hunter.....	50 45.37	02 23.21	do.....	
Hunting Creek Bridge, flag.....	47 33.46	03 24.92	do.....	
Johnson, house chimney.....	47 21.77	04 18.76	do.....	
Jones Point light-house (1863).....	47 25.34	02 27.12	do.....	
Langley church, south gable.....	56 51.05	09 37.83	do.....	
Lewinsville church, south gable.....	55 46.73	11 50.65	do.....	
Lyon.....	47 26.43	04 37.79	do.....	
Marcy.....	56 06.15	07 35.62	do.....	
Miner Hill.....	54 23.89	09 33.61	do.....	
Mount Vernon wharf signboard, Potomac River.	42 19.47	05 19.89	do.....	
Munson Hill, flag.....	51 36.30	08 44.10	do.....	
Occoquan.....	38 14.30	12 59.75	do.....	
Peach Grove.....	55 12.74	13 46.77	do.....	
Port Royal.....	10 24.09	11 24.63	do.....	
Rocker (A.), chimney on house.....	46 43.28	05 55.65	do.....	
Shipping Point, Potomac River.....	31 38.44	17 00.07	do.....	
Strong.....	53 49.24	05 20.10	do.....	
Square yellow house, cupola.....	49 09.03	04 41.26	do.....	
Telegraph pole.....	52 39.51	02 10.07	do.....	
Upton Hill.....	52 19.50	08 49.99	do.....	
View Tree, near Warrenton.....	44 01.97	50 09.98	do.....	
Watery Mountain.....	47 32.00	50 23.00	do.....	
White house, cupola.....	51 32.32	04 00.76	do.....	
Worth.....	48 52.90	05 55.56	do.....	
	38°-39°	78°-79°		
Bluff Mountain.....	38 26 26.00	78 25 00.00	do.....	
Clark.....	18 41.11	00 11.49	do.....	Do.
Forks.....	28 44.81	24 57.47	do.....	Do.
Hawksbill.....	33 19.00	23 44.00	do.....	
High Knob, probably Fire Mountain, south side of Manassas Gap, Blue Ridge.	53 12.13	06 43.84	do.....	Do.
Jannau.....	06 18.53	44 38.69	do.....	
Keller.....	55 08.99	23 31.30	do.....	

VIRGINIA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	38°-39°			78°-79°				
	°	'	"	°	'	"		
Marshall	38	46	33.82	78	12	10.28	C. & G. S.	Bull. 122.
Mary Rock		38	53.00		19	26.00	do	
McCormick Observatory, pier		01	58.06		31	20.62	do	
Peaked		23	33.97		46	12.63	do	
Peters Mountain		07	32.80		17	10.71	do	
Ragged Rock		32	06.00		18	54.00	do	
Rattlesnake		51	53.00		02	36.00	do	
Saddle Mountain		20	09.00		33	07.00	do	
Stonyman Mountain		35	52.00		22	20.00	do	
Strasburg		59	31.40		21	33.70	do	
Astronomical station		59	29.96		21	39.01	do	
Lutheran church		59	26.80		21	44.70	do	
Presbyterian church		59	12.21		21	46.37	do	
Thoroughfare Mountain, summit		24	52.00		09	25.00	do	
Turks Mountain		18	16.00		38	45.00	do	
University of Virginia, dome		02	08.31		30	13.01	do	
	38°-39°			79°-80°				
Elliott Knob	38	09	59.36	79	18	51.30	do	Do.
Flag Rock		02	33.00		46	23.00	do	
North		51	28.90		48	20.20	G. S.	Do.
North River Mountain		23	39.00		15	29.00	C. & G. S.	
Northeast Peak		09	45.00		31	19.00	do	
Shenandoah, Jack Mountain		24	22.00		30	48.00	do	
Sounding Knob, lone tree		20	47.00		35	25.00	do	
Staunton, astronomical station		08	46.54		04	19.08	do	
	37°-38°			76°-77°				
Fortress Monroe, flagstaff	37	00	05.93	76	18	32.10	do	
Tappahannock, Episcopal church spire.		55	39.38		51	31.35	do	
Yorktown		16	09.64		30	28.38	do	
Petersburg:	37°-38°			77°-78°				
Court-house	37	13	50.74	77	24	13.56	do	
Catholic church		13	38.65		24	24.29	do	
Presbyterian church		13	49.03		24	19.41	do	
Methodist church		13	39.77		24	09.73	do	
Richmond:								
Baptist College tower		33	08.94		27	21.32	do	
Capitol, flag pole on east end of building.		32	16.38		26	04.04	do	
Capitol, flagstaff on center of building.		32	19.50		26	01.66	do	
St. Paul's church		32	23.48		26	06.82	do	
Roslyn:								
Astronomical station		14	28.33		23	50.71	do	
Petersburg transit		14	25.48		23	45.14	do	
	37°-38°			78°-79°				
Baker	37	12	09.57	78	38	39.19	G. S.	Do.
Humpback		56	55.91		53	57.24	C. & G. S.	Do.
Leigh		12	14.21		21	32.82	G. S.	Do.
Mountain southwest of Humpback		54	58.00		57	16.00	C. & G. S.	
Pilot Mountain, summit		19	30.00		58	05.00	do	
Spear		33	42.91		45	46.66	do	Do.
Sugarloaf, summit		46	57.00		49	16.00	do	
Three Ridge, summit		51	29.00		59	02.00	do	
Willis		28	22.68		27	52.90	do	
	37°-38°			79°-80°				
Amherst court-house cupola	37	35	06.30	79	03	04.30	do	
Apple Orchard, summit		31	03.00		30	41.00	do	
Bald Friar, summit		49	12.00		03	42.00	do	
Bald Knob		55	32.64		51	04.72	do	
Bald Knob, No. 1		51	00.00		55	35.00	do	
Big Level Mountain, lone tree		56	34.00		06	47.00	do	
Brushy		00	37.16		19	41.32	G. S.	Do.
Campbell court-house, jail		16	33.30		06	11.60	C. & G. S.	
Chandler Mountain, summit		20	12.00		08	12.00	do	
Cole Mountain		45	06.00		12	19.00	do	
Covington, transit		47	17.00		59	38.40	do	
Dry Mountain		06	22.90		03	47.99	G. S.	Do.
First peak northeast of Flat Top, sum- mit.		28	47.00		32	44.00	C. & G. S.	
Flat Top		27	06.85		34	58.40	do	Do.
Johnson		11	32.78		21	42.56	G. S.	Do.
Johnson Mountain, summit		11	51.00		21	06.00	C. & G. S.	Do.
Long		17	27.65		05	10.24	do	
Lynchburg court-house, belfry		24	49.10		08	40.52	do	
Mount Pleasant, summit		44	27.00		10	17.00	do	
Mountain northwest of Mount Pleas- ant.		44	24.00		13	25.00	do	

VIRGINIA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	37°-38°			79°-80°				
	°	'	"	°	'	"		
No Business Mountain, summit.....	37	28	13.00	79	22	35.00	C. & G. S.	
Northeast House Mountain.....		49	45.00		32	36.00	do	
Rocky Mountain.....		46	01.00		11	16.00	do	
Round Top, near James River.....		28	08.00		00	27.00	do	
Second peak northeast of Flat Top.....		29	46.00		30	55.00	do	
Southwest House Mountain.....		49	51.00		33	43.00	do	
Southwest peak of Otter, summit.....		26	00.00		36	18.00	do	
Smith.....		00	51.53		33	56.93	do	Bull. 122.
Tobacco Row.....		33	55.76		11	26.17	do	Do.
Tyrecana church.....		23	27.70		06	18.30	do	
Weavers Knob summit.....		18	14.00		49	25.00	do	
	37°-38°			80°-81°				
Buckhorn.....	37	17	33.55	80	58	49.30	G. S.	Do.
Cahas.....		07	01.95		00	56.64	do	Do.
Peak.....		01	22.00		44	54.50	do	Do.
Potts.....		36	02.90		08	45.00	do	Do.
Salt Pond.....		21	00.80		32	15.30	do	Do.
Streets.....		09	46.10		11	33.90	do	Do.
	37°-38°			81°-82°				
Bear Wallow.....	37	14	38.60	81	44	50.20	do	Do.
Big Bend.....		01	37.80		10	56.40	do	Do.
Dial Rock.....		09	58.40		25	00.30	do	Do.
Morris.....		02	57.50		37	01.60	do	Do.
	37°-38°			82°-83°				
Big Butt.....	37	03	09.20	82	02	08.00	do	Do.
	36°-37°			76°-77°				
Newport News.....	36	58	00.81	76	25	21.52	do	
Norfolk:								
Baptist church spire.....		51	01.31		17	13.75	do	
City hall.....		50	50.59		17	19.95	do	
	36°-37°			79°-80°				
Chestnut Mountain, summit.....	36	50	54.00	79	50	46.00	do	
Turkey.....		50	11.19		39	28.25	do	Do.
White Oak.....		42	51.80		25	34.90	do	Do.
	36°-37°			80°-81°				
Buffalo.....	36	47	46.25	80	28	39.04	C. & G. S.	Do.
Bull Mountain.....		41	34.97		13	29.93	do	
Draper.....		57	56.70		53	53.50	G. S.	Do.
Rich.....		34	37.60		49	31.90	do	Do.
	36°-37°			81°-82°				
Lookout.....	36	40	04.50	81	10	03.20	do	Do.
Red Rock.....		55	20.00		48	22.00	do	Do.
Ripshin.....		50	28.30		21	37.80	do	Do.
Rogers.....		39	36.10		32	42.00	do	Do.
White Top.....		38	21.76		36	12.48	do	Do.
	36°-37°			82°-83°				
Clinch.....	36	49	44.50	82	04	46.00	do	Do.
Goodson.....		35	49.10		11	13.10	C. & G. S.	
High Knob.....		53	33.00		37	46.10	G. S.	Do.

WEST VIRGINIA.

	40°-41°			80°-81°				
	°	'	"	°	'	"		
Wheeling.....	40	04	04.00	80	43	36.60	C. & G. S.	Rept. '84.
	39°-40°			78°-79°				
Capon.....	39	08	36.40	78	26	03.70	do	Bull. 122.
Locks.....		26	27.20		11	33.40	do	
Paddy.....		00	24.40		33	47.70	G. S.	Do.
Sleepy Creek Mountain.....		37	12.00		07	03.00	C. & G. S.	
	39°-40°			79°-80°				
Felton.....	39	23	21.70	79	39	07.10	G. S.	Do.
Laurel.....		09	34.70		49	42.50	do	Do.
Nelson.....		27	53.30		56	06.20	do	Do.
	39°-40°			80°-81°				
Bear Knob.....	39	03	25.10	80	17	23.70	do	Do.
Cameron.....		49	46.00		34	22.50	C. & G. S.	Rept. '84.
Clarksburg.....		16	56.00		20	22.05	do	Do.
Grafton.....					01	40.80	do	Do.
Little Bald.....		20	09.10		14	22.70	G. S.	Bull. 122.
Sinking Creek.....		01	17.60		51	56.80	do	Do.
Sugar Loaf.....		02	02.75		33	49.70	do	Do.

WEST VIRGINIA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	38°-39° ° ' "	79°-80° ° ' "		
Bickles	38 56 03.40	79 43 54.40	G. S	Bull. 122.
Briery Branch Mountain	27 45.30	14 31.30	C. & G. S	Do.
Green	53 50.70	26 36.70	G. S	Do.
North	51 28.90	48 20.20	do	Do.
Paddy	15 56.77	47 46.29	do	Do.
Panther Knob	34 07.00	10 14.90	C. & G. S	Do.
Panther	33 48.30	29 45.30	G. S	Do.
Rich	50 01.85	56 22.60	do	Do.
Slate Springs	30 35.71	11 03.66	do	Do.
Spruce	41 58 70	31 59.50	do	Do.
	38°-39°	80°-81°		
Big Run	38 47 41.90	80 15 30.15	do	Do.
Beech	06 44.63	36 18.88	do	Do.
Briery	08 39.65	20 40.40	do	Do.
Cedar Creek	54 30.30	53 52.70	do	Do.
Cold Knob	03 43.00	28 30.00	C. & G. S	
Grassy Knob	03 20.00	30 14.00	do	
High Knob	15 46.10	12 20.80	do	
Locust	53 28.15	41 06.65	G. S	Do.
Job Knob	04 46.70	32 32.65	C. & G. S	
Nicholas court-house belfry	16 50.50	52 02.50	do	
Powell Mountain	18 10.00	48 37.00	do	
Rush	55 25.00	32 42.60	G. S	Do.
Summersville	16 55.42	52 07.65	C. & G. S	Do.
	38°-39°	81°-82°		
Big Rocks	38 30 51.23	81 55 29.23	do	
Charleston	21 07.20	38 00.00	do	Rept. '84.
Creed	24 16.82	33 35.50	do	
Elk	22 20.73	36 56.57	G. S	
Ferguson	20 37.96	38 14.93	C. & G. S	
Fort Scammon	21 06.32	39 16.94	G. S	
Gauley Bridge	09 08.70	12 57.00	C. & G. S	
Gauley Mountains	10 50.00	04 27.00	do	
Do	10 53.00	04 19.00	do	Bull. 122.
Holmes	25 40.87	35 34.31	do	Do.
Martin	21 25.36	36 18.14	do	
Table Rock	11 18.56	36 53.13	do	Do.
	38°-39°	82°-83°		
Davis	38 21 06.31	82 21 12.15	do	
Gebhardt	31 45.73	15 10.88	do	
Oakland	21 46.57	38 52.68	do	
Pigeon	13 44.13	03 59.86	do	
Piney	26 39.66	03 28.84	do	
Point Pleasant	50 28.00	08 45.30	do	Rept. '84.
	37°-38°	80°-81°		
Big Clear Creek Mountain	37 57 52.00	80 36 05.00	do	Do.
Big Sewall Mountain	54 35.40	55 42.36	do	Do.
Keeney	46 24.91	42 19.05	do	Do.
	37°-38°	81°-82°		
Burning Rock	37 41 38.00	81 41 51.60	G. S	Bull. 122.
Ivy	47 15.78	29 28.28	C. & G. S	
Long Flat Mountain	53 18.00	25 46.00	do	
Do	53 16.00	26 00.00	do	
Paint Creek	56 50.79	18 28.82	do	Do.
Pilot	29 04.30	16 18.80	G. S	Do.
Sharp Peak	53 56.00	19 52.00	C. & G. S	
Townsend Mountain	56 30.00	17 43.00	do	

NORTH CAROLINA.

	36°-37° ° ' "	80°-81° ° ' "		
Lauratown	36 22 33.00	80 22 17.00	C. & G. S	
Moore	23 53.60	16 59.24	do	
Pilot Knob	20 24.53	28 28.19	do	
Warrior Mountain	29 13.00	51 45.00	do	
	36°-37°	81°-82°		
Bullhead	36 26 49.70	81 04 00.70	do	Bull. 122.
Elk Knob	20 40.00	42 31.00	do	
Flat Top Mountain, Blue Ridge	09 44.00	40 37.00	do	
Grandfather	06 41.50	48 36.90	do	Do.
Negro	24 11.60	27 48.70	do	Do.
Poore	02 47.66	09 24.24	do	Do.
Snake	19 51.10	42 28.20	do	Do.

NORTH CAROLINA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	35°-36° ° ' "	80°-81° ° ' "		
Statesville astronomical station	35 46 56.55	80 53 39.94	C. & G. S.	Bull. 122.
Statesville, Simonton College	46 57.94	53 39.05	do	
Young	44 14.49	38 51.16	do	
	35°-36° ° ' "	81°-82° ° ' "		
Anderson	35 33 57.32	81 05 26.80	do	Do.
Benn	33 55.06	39 37.55	do	
Hibriton	54 25.40	29 22.70	G. S.	
King	12 27.87	18 45.59	C. & G. S.	Do.
Lincolnton court-house cupola	28 16.87	15 25.67	do	Do.
Table Rock	53 27.70	52 59.00	G. S.	
Thicketty	06 48.24	46 08.21	C. & G. S.	
	35°-36° ° ' "	82°-83° ° ' "		
Balsam	35 22 02.10	82 59 24.70	G. S.	Do.
Big Bald	59 23.50	29 25.00	do	Do.
Mitchell	45 53.60	15 54.50	do	Do.
Pisgah	25 32.50	45 24.60	do	Do.
Sandymush	40 41.70	53 01.40	do	Do.
	35°-36° ° ' "	83°-84° ° ' "		
Cheowah	35 19 32.20	83 40 50.70	do	Do.
Christie Peak	23 09.40	58 10.10	do	Do.
Cowee	19 39.90	20 10.00	do	Do.
Thomas Bald	02 07.30	32 16.80	do	Do.
Thunderhead	34 06.80	42 22.50	do	Do.
Tusquittah	08 42.50	43 35.20	do	Do.
	35°-36° ° ' "	84°-85° ° ' "		
Haw Knob	35 18 34.20	84 01 35.20	do	Do.
Pack	03 00.90	17 10.00	do	Do.

SOUTH CAROLINA.

	35°-36° ° ' "	82°-83° ° ' "		
Hogback	35 10 12.25	82 17 26.34	C. & G. S.	Bull. 122.
Pinnacle	02 00.85	44 30.02	do	Do.
	34°-35° ° ' "	81°-82° ° ' "		
Wofford	34 57 32.31	81 56 06.73	do	Do.
Greenville:	34°-35° ° ' "	82°-83° ° ' "		
Baptist spire	34 50 59.78	82 24 05.08	do	Do.
Episcopal spire cross	51 02.58	23 40.79	do	
Furman University turret	50 29.15	24 11.34	do	
White tower, conical dark roof	50 55.36	23 44.33	do	
Mauldin	49 18.46	38 05.09	do	
Paris	56 29.27	24 40.05	do	Do.

GEORGIA.

	34°-35° ° ' "	83°-84° ° ' "		
Blood	34 44 23.24	83 56 13.22	C. & G. S.	Bull. 122.
Currahee	31 45.13	22 33.32	do	Do.
Dahlonaga Agricultural College, center of roof.	31 47.95	59 13.25	do	Do.
Rabun	57 55.74	17 59.26	do	
Skitt	30 20.55	43 19.83	do	
	34°-35° ° ' "	84°-85° ° ' "		
Cohutta	34 53 23.51	84 34 26.44	do	Do.
Grassy	29 10.58	19 53.04	do	
Pine Log	19 18.31	38 13.66	do	
Pine Mountain	10 36.61	44 41.67	do	Do.
Sawnee	14 12.12	09 38.83	do	
Sharp Top Mountain	26 21.00	30 26.00	do	
Sweat	04 01.44	27 21.54	do	Do.
	34°-35° ° ' "	85°-86° ° ' "		
Coosa	34 13 59.30	85 14 04.32	do	Do.
Gulf	37 32.16	28 02.49	do	
High Point	51 49.80	23 32.70	G. S.	
Johns Mountain	37 23.23	05 53.77	C. & G. S.	Do.
Mount Lavender	19 19.57	17 18.39	do	Do.
Rocky Face	49 26.30	00 28.10	G. S.	Do.

GEORGIA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	33°-34°	81°-82°		
Augusta:	° ' "	° ' "		
Astronomical station in post-office grounds.	33 28 20.60	81 57 55.40	C. & G. S.	
Post-office flagstaff	28 22.18	57 53.96	do	
	33°-34°	83°-84°		
Academy	33 57 32.66	83 59 28.51	do	
Atlanta:	33°-34°	84°-85°		
Barracks flagstaff	33 44 38.99	84 24 39.95	do	
Capitol flagstaff	45 19.32	23 29.15	do	
Carnes Mountain	59 35.76	00 50.03	do	
Kenesaw	58 34.37	34 45.74	do	
Lost Mountain	56 52.74	41 50.75	do	
Marietta:				
Court-house, brown spire	57 08.74	32 55.92	do	
National Cemetery flagstaff	57 04.15	32 30.66	do	
Middle base	54 21.74	16 37.79	do	
Northeast base	55 57.86	14 09.44	do	
Southwest base	52 51.83	18 56.41	do	
Stone Mountain	48 22.07	08 45.89	do	
	32°-33°	83°-84°		
Macon, transit near Academy	32 50 25.38	83 37 33.82	do	

FLORIDA.

	29°-30°	82°-83°		
Gainesville:	° ' "	° ' "		
Astronomic station	29 39 07.90	82 19 20.90	C. & G. S.	
Court-house rod	39 04.53	19 23.80	do	
	29°-30°	84°-85°		
Apalachicola, flagstaff	29 43 30.00	84 59 00.00	do	
	27°-28°	82°-83°		
Alafia	27 50 04.46	82 23 22.06	do	
Ball	54 23.27	24 51.27	do	
Catfish Point	50 43.47	28 06.75	do	
Fort Brooks, barracks cupola	56 33.24	27 21.57	do	
Gadsden Point	49 19.74	28 15.05	do	
Geode	53 19.96	28 43.30	do	
Island	55 24.73	27 07.72	do	
Stick	53 23.90	24 19.60	do	
Old	51 52.11	23 58.72	do	

ALABAMA.

	34°-35°	85°-86°		
	° ' "	° ' "		
Brandon	34 23 07.35	85 45 12.72	C. & G. S.	Bull. 122.
Indian	01 49.94	25 31.10	do	Do.
Weisner	01 35.63	40 27.43	do	
	34°-35°	86°-87°		
Athens, court-house spire	34 48 10.56	86 58 17.46	do	
Aurora	08 47.87	11 00.80	do	
Capshaw	49 04.47	44 17.40	do	
Gunter	34 06.83	10 20.30	do	Do.
Huntsville:				
Episcopal church spire	43 49.38	35 00.20	do	
Cupola of court-house	43 49.09	35 06.02	do	
Knob Valhermosa	30 53.15	38 36.93	do	
Madkin Mountain-tree	40 02.10	38 37.38	do	
Monte Sano, north end	44 52.10	32 03.54	do	
Mocre Hill	21 32.50	15 53.56	do	
Rowe Mountain	32 22.32	31 26.59	do	
Smither	48 59.29	36 58.34	do	
Summit	12 16.36	29 05.20	do	
Wilson Mountain	25 07.51	49 02.85	do	
	34°-35°	87°-88°		
Penit	34 26 08.90	87 20 14.29	do	
	33°-34°	85°-86°		
Chehahaw	33 29 08.03	85 48 31.14	do	
	33°-34°	86°-87°		
Alpine	33 24 41.50	86 12 28.20	do	
Cahaba	44 58.80	31 24.60	do	

ALABAMA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	33°-34°	86°-87°		
	° / "	° / "		
Columbian	33 11 40.80	86 35 00.70	C. & G. S	
Horn	17 51.40	04 29.70	do	
Kahatchee	13 36.80	21 38.60	do	
Laurel	23 50.20	34 53.80	do	
Warnock	59 48.67	41 51.96	do	
	32°-33°	86°-87°		
	° / "	° / "		
Jamison	32 55 39.20	86 38 38.40	do	
Montgomery	22 45.46	17 57.29	do	Rept. '84.
Weogufka	58 38.70	21 20.20	do	Do.
Wilder	38 01.77	29 38.53	do	Do.
	31°-32°	85°-86°		
	° / "	° / "		
Eufaula	31 53 40.91	85 08 18.62	do	Do.

MISSISSIPPI.

	34°-35°	90°-91°		
	° / "	° / "		
Adams	34 34 15.16	90 33 57.10	Miss. R. C	Rept. '87.
Alexander	43 16.01	30 39.08	do	Do.
Anderson	08 57.54	53 14.45	do	Rept. '82.
Australia	04 01.51	53 17.63	do	Do.
Battle Island	39 02.60	28 59.63	do	Rept. '87.
Belfor	28 32.01	34 05.72	do	Rept. '82.
Bennett	50 49.74	20 06.11	do	Rept. '87.
Bowie Point	50 45.81	21 31.44	do	Do.
Bordeaux Chute	44 52.78	30 12.88	do	Do.
Brinkley	45 45.18	25 25.75	do	Do.
Buck Island	51 37.17	18 55.16	do	Do.
Chute	52 11.57	18 13.53	do	Do.
Buckshot	35 32.69	33 13.97	do	Do.
Buzzard	16 06.23	47 50.96	do	Rept. '82.
Carter	44 53.77	29 33.76	do	Rept. '87.
Cemetery	32 36.78	35 36.59	do	Rept. '82.
Clark	47 37.99	26 03.07	do	Rept. '87.
Commerce	48 55.18	26 09.27	do	Do.
Cottonwood	51 22.86	21 45.26	do	Do.
Crews	07 08.75	56 05.31	do	Rept. '82.
Delta	24 44.55	35 11.90	do	Do.
Dennis	02 15.36	54 17.38	do	Do.
Donaldson	13 49.01	51 31.98	do	Do.
Dyers	02 55.05	53 39.02	do	Do.
Frederick	40 09.42	27 33.19	do	Rept. '87.
Friar Point	22 54.28	37 53.29	do	Rept. '82.
Glendale	30 09.51	34 19.11	do	Do.
Grider	54 59.21	15 59.59	do	Rept. '87.
Gratlin	11 53.25	50 54.04	do	Rept. '82.
Harcklerode	56 29.35	14 40.59	do	Rept. '87.
Helena Island	34 41.48	32 16.20	do	Do.
Horseshoe Lake	52 41.57	18 31.27	do	Do.
Hulberton	17 07.70	47 02.72	do	Rept. '82.
Hurricane Point	02 04.31	55 07.21	do	Do.
Island 64	14 26.29	51 10.74	do	Do.
Island 66	10 58.31	49 36.36	do	Do.
Island 69	04 36.71	54 14.06	do	Do.
Jackson Point	14 10.52	52 49.62	do	Do.
John H	54 15.75	17 13.95	do	Rept. '87.
Jones	10 05.69	49 21.65	do	Rept. '82.
Lamb	55 11.65	15 13.72	do	Rept. '87.
Lucker	21 29.59	41 15.70	do	Rept. '82.
Magenta	01 54.29	56 08.87	do	Do.
Malone	08 43.89	51 55.52	do	Do.
Miller Point	22 29.43	42 40.86	do	Do.
Montezuma	26 25.63	35 04.60	do	Do.
Moon Lake	44 18.52	27 02.10	do	Rept. '87.
New Hope	08 40.33	50 57.01	do	Rept. '82.
Oasis	00 27.02	57 15.61	do	Do.
O. K	38 02.19	28 52.78	do	Rept. '87.
Overflow	19 57.67	44 05.46	do	Rept. '82.
Parker	06 35.55	55 25.05	do	Do.
Perry	42 10.17	29 33.42	do	Rept. '87.
Platon	44 22.15	30 39.14	do	Do.
Polk	50 40.81	22 46.48	do	Do.
Pushmataha	09 19.85	55 21.60	do	Rept. '82.
Quitman	11 50.49	52 03.50	do	Do.
Richardson	11 47.29	49 12.65	do	Do.
Robinsonville	09 10.79	49 09.90	do	Do.

MISSISSIPPI—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	34°-35°			90°-91°				
	°	'	"	°	'	"		
Robson.....	34	15	00.53	90	48	56.60	Miss. R. C	Rept. '82.
Rozzell.....		23	23.01		36	55.84	do	Do.
Russell.....		18	39.71		43	36.73	do	Do.
St. Johns.....		05	29.39		54	02.32	do	Do.
Sand Point.....		49	52.64		24	30.51	do	Rept. '87.
Sandford.....		01	04.44		56	56.25	do	Rept. '82.
Ship.....		21	43.15		38	57.13	do	Do.
Shoo-Fly.....		38	55.08		31	23.40	do	Rept. '87.
Star Landing.....		54	14.02		15	56.80	do	Do.
State Land.....		20	48.90		44	28.32	do	Rept. '82.
State Levee.....		13	55.44		50	36.04	do	Do.
State Line.....		58	50.03		16	29.40	do	Rept. '87.
Sunflower Landing.....		10	23.83		48	37.70	do	Rept. '82.
Turner.....		38	29.74		33	50.58	do	Rept. '87.
Ude.....		32	12.74		33	44.53	{ do } C. & G. S.	Rept. '82.
Wilkinson.....		21	58.88		44	36.95	Miss. R. C	Do.
Williams.....		52	36.22		17	31.83	do	Rept. '87.
Yazoo Pass.....		26	16.44		33	18.66	do	Rept. '82.
	34°-35°			91°-92°				
Smith Point.....	34	00	16.86	91	02	20.43	do	Do.
	33°-34°			90°-91°				
Bee Hive.....	33	59	00.01	90	59	51.11	do	Do.
Brandenburg.....		59	04.45		58	15.48	do	Do.
Hill.....		58	44.65		59	13.45	do	Do.
Island 71.....		59	36.32		57	55.16	do	Do.
Judge E.....		57	55.68		58	26.05	do	Do.
North Base.....		59	52.48		56	44.91	do	Do.
R. Jones.....		58	27.85		59	56.60	do	Do.
South Base.....		59	11.37		57	01.86	do	Do.
	33°-34°			91°-92°				
Antler.....	33	59	20.92	91	01	23.58	do	Do.
Argyle.....		26	56.00		04	47.15	do	Do.
Ashbrook.....		28	45.81		13	03.28	do	Do.
Ashland.....		27	54.03		07	13.05	do	Do.
Bar.....		03	02.17		08	32.72	do	Rept. '87.
Bar Point.....		35	05.36		12	43.41	do	Rept. '82.
Barnes.....		27	23.83		12	12.93	do	Do.
Beulah Lake.....		48	03.19		03	40.71	do	Do.
Buck Ridge.....		39	57.49		04	30.87	do	Do.
Campbell.....		26	54.00		05	48.00	do	Do.
Carolina.....		00	37.13		09	12.36	do	Rept. '87.
Gin, northwest gable.....		00	39.45		09	05.19	do	Do.
Carter.....		26	14.45		07	06.06	do	Rept. '82.
Catfish Point.....		42	00.56		09	12.12	do	Do.
Chaff.....		08	43.77		06	02.10	do	Rept. '87.
Childers.....		38	09.99		08	33.13	do	Rept. '82.
Compton.....		16	00.59		06	51.26	do	Rept. '87.
Concordia Bayou.....		58	21.37		02	48.89	do	Rept. '82.
Content.....		39	55.07		07	05.07	do	Do.
Cottage.....		08	06.06		09	26.41	do	Rept. '87.
Craig's gin chimney.....		22	19.57		08	34.82	do	Do.
Crow Point.....		46	09.61		07	57.18	do	Rept. '82.
Cypress Tow Head.....		42	30.01		11	32.55	do	Do.
Deer Point.....		43	00.14		04	56.05	do	Do.
Delolme.....		35	54.63		10	19.27	do	Do.
Dry Chute.....		44	03.73		07	13.14	do	Do.
Duncan.....		33	05.78		12	46.47	do	Do.
Easton.....		36	38.67		07	57.83	do	Do.
Eutaw.....		38	54.64		09	36.14	do	Do.
Eutopiot.....		29	53.98		11	33.30	do	Do.
Ezell.....		52	32.69		02	53.38	do	Do.
Fisher.....		45	30.82		05	56.25	do	Do.
Floryville.....		51	07.77		01	59.48	do	Do.
Gill.....		59	07.89		03	37.70	do	Do.
Glenora.....		11	53.28		04	44.11	do	Rept. '87.
Gin chimney.....		11	12.52		04	07.66	do	Do.
Greenville:								
Episcopal church spire.....		24	40.21		03	57.30	do	Do.
Base, north end.....		24	19.23		03	58.77	do	Do.
Base, south end.....		23	18.19		04	32.44	do	Do.
Highland.....		21	14.06		08	23.76	do	Do.
Hill.....		08	11.60		07	52.24	do	Do.
Island 76.....		40	22.36		03	24.90	do	Rept. '82.
Island 77.....		41	43.10		11	57.41	do	Do.
Island 80.....		30	46.72		12	17.70	do	Do.
Island 81.....		29	50.55		12	37.55	do	Do.
Island 84.....		18	59.03		09	25.70	do	Rept. '87.
Ivy Point.....		34	16.25		13	01.40	do	Rept. '82.
Jack.....		22	22.04		05	54.04	do	Rept. '87.

MISSISSIPPI—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	33°-34°			91°-92°				
	°	'	"	°	'	"		
Kentucky Landing	33	39	46.90	91	05	42.98	Miss. R. C.	Rept. '82.
Kershaw		02	01.44		08	50.00	do	Rept. '87.
Leota		04	27.98		08	54.46	do	Do.
Levee		09	26.63		05	11.49	do	Do.
Meadow Point		44	53.78		08	04.88	do	Rept. '82.
Miller Bend		28	54.16		07	27.44	do	Do.
Mohawk Landing		42	51.73		03	37.01	do	Do.
Morris		29	37.74		08	20.50	do	Do.
Moss Lake		29	47.97		10	29.28	do	Do.
Mound Place		35	50.78		08	59.88	do	Do.
North base		24	19.23		03	58.77	do	Do.
North Island 82		29	09.51		09	37.92	Miss. R. C.	Do.
Offutt		31	04.79		11	20.36	do	Do.
Peak		58	47.54		00	28.14	do	Do.
Phillips		28	47.73		11	26.47	do	Do.
Pigeon Point		40	33.15		11	42.54	do	Do.
Port Anderson		32	14.79		11	59.37	do	Do.
Prentiss		46	37.58		04	15.29	do	Do.
Pride Point		49	32.50		02	45.10	do	Do.
Quarters		10	33.09		04	35.12	do	Rept. '87.
Randolph		26	23.23		08	00.57	do	Rept. '82.
Refuge		17	31.03		08	06.68	do	Rept. '87.
Post-office chimney		17	34.38		08	06.14	do	Do.
Oilworks, cupola		17	20.80		07	55.66	do	Do.
Richardson		21	46.29		06	30.37	do	Do.
Rock Head		39	38.01		11	01.39	do	Rept. '82.
Sand Point		27	45.79		13	14.60	do	Do.
Sedge		13	08.19		05	42.62	do	Rept. '87.
Shady Side		30	07.24		09	09.88	do	Rept. '82.
Shelby		35	47.49		11	32.11	do	Do.
House, chimney		17	44.83		08	07.95	do	Rept. '87.
Singer		42	37.47		10	27.39	do	Rept. '82.
Solona		25	48.37		07	34.70	do	Do.
South Base		23	18.19		04	32.44	do	Do.
South Island 82		27	20.47		08	11.60	do	Do.
Stella, warehouse gable		09	03.04		05	24.89	do	Rept. '87.
Stokes		56	01.30		02	06.02	do	Rept. '82.
Telegraph		09	51.84		04	32.80	do	Rept. '87.
Terrene		54	01.73		03	21.28	do	Rept. '82.
Torpley		26	54.68		07	37.91	do	Do.
Victoria		57	46.70		02	26.67	do	Do.
Walnut Point		14	08.83		06	50.71	do	Rept. '87.
Warfield		20	16.41		09	33.52	do	Do.
Waxhaw		54	52.72		02	53.36	do	Rept. '82.
Wickliffe		07	44.33		10	33.42	do	Rept. '87.
Widow		59	37.32		03	47.05	do	Rept. '82.
Wildwood		45	32.29		07	22.71	do	Do.
Williams, chimney		10	57.25		04	25.98	do	Rept. '87.
Willow Point		43	19.48		05	57.40	do	Rept. '82.
Worthington		06	24.70		10	03.48	do	Rept. '87.
Balcony		05	21.84		09	15.06	do	Do.
Wrights Point, No. 2		48	56.28		03	28.82	do	Rept. '82.
Base:	32°-33°			90°-91°				
Northeast end (delta)	32	20	01.61	90	54	53.95	do	Rept. '87.
Southwest end (delta)		19	04.60		56	13.19	do	Do.
Big Bayou		16	02.11		56	34.22	do	Do.
Charley		13	42.30		58	28.56	do	Do.
Delta:							do	Do.
Court-house, flagstaff at east end		19	06.08		56	13.41		
Engine-house cupola		19	34.43		55	30.53	do	Do.
Fort		20	26.16		53	05.04	do	Do.
Hutchinson		21	09.42		57	40.78	do	Do.
Island		21	07.11		53	41.73	do	Do.
Kemp		17	25.10		56	01.84	do	Do.
King		20	35.58		56	37.18	do	Do.
King (Mrs.), house cupola		20	37.15		56	36.86	do	Do.
McGee		23	03.23		52	57.11	do	Do.
Myer		13	44.93		57	10.77	do	Do.
New house, south gable		21	12.24		57	38.86	do	Do.
New King		20	38.82		56	46.03	do	Do.
Simrall		13	00.14		58	36.07	do	Do.
Vicksburg:								
Catholic church spire		20	54.63		52	54.68	do	Do.
Court-house cupola		21	05.41		52	45.16	do	Do.
Methodist church spire		20	52.15		52	46.41	do	Do.
National cemetery flagstaff		22	25.38		52	06.45	do	Do.
Trinity church spire		20	49.18		52	49.49	do	Do.
Walnut, house chimney		18	01.69		54	32.39	do	Do.
Waddel, house, southeast chimney		21	01.60		59	19.49	do	Do.

MISSISSIPPI—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	32°-33°	90°-91°		
	° ' "	° ' "		
Warrenton	32 14 54.78	90 56 35.30	Miss. R. C.	Rept. '87.
Yazoo	22 07.31	59 10.54	do	Do.
	32°-33°	91°-92°		
Albemarle	32 37 14.10	91 02 00.70	do	Do.
Arcadia	39 56.17	08 25.81	do	Do.
Benham, southeast chimney	51 27.07	07 17.06	do	Do.
Ben Lomond, gin chimney	47 49.62	08 35.32	do	Do.
Big Black	06 35.45	02 34.07	do	Do.
Brunswick	34 31.83	03 51.56	do	Do.
Burleigh	37 53.84	04 05.56	do	Do.
Cabin Home	35 24.87	02 13.60	do	Do.
Cannon	08 15.19	02 33.23	do	Do.
Cordell	58 28.43	07 55.05	do	Do.
Cotton gin	37 56.93	02 59.22	do	Do.
Duncan	51 09.11	06 19.57	do	Do.
Duncannon :				
Gin chimney	50 22.44	06 18.74	do	Do.
Gin ventilator	49 43.49	06 47.56	do	Do.
Duncansby	57 47.00	05 35.65	do	Do.
Eagle	29 56.43	06 29.44	do	Do.
Elder	05 10.25	03 21.17	do	Do.
Farland	45 00.11	05 35.47	do	Do.
Gander	07 34.12	03 36.38	do	Do.
Gantt	13 02.34	00 28.53	do	Do.
Grand Gulf Island	01 34.56	04 59.75	do	Do.
Green	56 07.07	04 38.54	do	Do.
Guy	11 43.57	01 31.81	do	Do.
Gynn	34 11.08	04 34.11	do	Do.
Hall, store, west gable	43 10.68	03 49.89	do	Do.
Hankinson	12 14.84	01 42.17	do	Do.
Hays	42 42.11	04 19.86	do	Do.
Hughes	00 30.27	05 57.88	do	Do.
Ingersoll	45 57.86	08 55.75	do	Do.
Levee	25 25.23	01 15.48	do	Do.
Lewis	58 27.35	09 13.76	do	Do.
House, chimney, north end	58 30.98	09 18.28	do	Do.
Mayerville, warehouse, northeast gable	54 00.98	03 30.48	do	Do.
Mayersville	54 20.22	04 08.53	do	Do.
McBurney	27 42.24	02 11.12	do	Do.
Melbourne, chimney	38 39.97	10 14.72	do	Do.
Montgomery, house, cupola	45 55.01	10 09.12	do	Do.
Morgan	08 52.55	00 54.77	do	Do.
No Place	37 50.46	07 59.15	do	Do.
North 95	44 41.02	04 48.80	do	Do.
Oakland, gin chimney	50 46.72	06 00.44	do	Do.
Poverty Point	59 15.82	12 28.57	do	Do.
Powell, house, southeast chimney	42 58.34	03 59.76	do	Do.
Pugh	25 05.92	00 22.92	do	Do.
Purvis	27 57.47	03 22.04	do	Do.
Richardson	59 37.09	10 44.61	do	Do.
Sand Bar	35 03.73	03 14.56	do	Do.
Sand Island	28 39.08	04 59.09	do	Do.
Sarah Island	58 19.39	11 20.24	do	Do.
Sartoris	48 01.67	08 55.08	do	Do.
Shiloh	41 49.58	05 31.27	do	Do.
Shipland	44 52.53	07 14.16	do	Do.
Shoot	38 15.41	08 37.55	do	Do.
Short	46 29.19	10 06.62	do	Do.
South 95	43 42.89	04 10.32	do	Do.
Stock Island	49 33.32	07 50.00	do	Do.
Swamp	04 39.54	04 48.38	do	Do.
Sycamore	04 39.46	06 26.06	do	Do.
Tennessee	37 50.08	06 11.00	do	Do.
Gin chimney	38 12.62	06 09.67	do	Do.
Thrasher	02 34.17	05 18.64	do	Do.
Walton, 2	13 14.99	01 09.70	do	Do.
Williams	10 28.87	00 30.25	do	Do.
Do	58 12.73	06 39.77	do	Do.
Willows	32 10.40	05 11.60	do	Do.
Winslow	47 08.44	09 06.65	do	Do.
Yucatan Bar	03 46.77	07 35.78	do	Do.
	31°-32°	91°-92°		
Allaway	31 15 43.24	91 34 18.92	do	Do.
Arnolia	33 33.14	26 41.28	do	Do.
Ashland	48 25.37	20 49.40	do	Do.
Bartlett	05 32.79	35 33.21	do	Do.
Bayou Pierre	57 54.70	08 56.12	do	Do.
Block House Hill	04 46.86	32 54.62	do	Do.
Bluff	38 43.85	23 11.93	do	Do.
Gin	01 46.63	32 50.19	do	Do.

MISSISSIPPI—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	31°-32°			91°-92°				
	°	'	"	°	'	"		
Bourbon.....	31	23	20.03	91	28	48.51	Miss. R. C	Rept. '87.
Brenham.....		37	14.83		25	19.38	do	Do.
Bruinsburg.....		55	54.05		10	24.75	do	Do.
Buena Vista.....		49	04.48		19	38.29	do	Do.
Burnett.....		44	54.48		21	30.97	do	Do.
Butler Bluff.....		25	20.27		25	42.88	do	Do.
Carthage.....		31	59.57		27	29.54	do	Do.
Cerro Gordo.....		15	47.23		32	51.36	do	Do.
Gin stack.....		15	39.05		32	54.34	do	Do.
Clark.....		52	35.12		13	34.49	do	Do.
Clarksville, chimney.....		03	46.04		33	12.48	do	Do.
Cole Island.....		46	18.22		21	59.24	do	Do.
Corena.....		20	16.81		31	18.57	do	Do.
Gin stack.....		19	58.96		31	00.40	do	Do.
Deadman Bend, Government light.....		16	14.82		31	42.30	do	Do.
Deer Park, gin chimney.....		24	29.28		33	02.67	do	Do.
Duck Bar.....		43	02.42		23	24.65	do	Do.
Dunham Bar.....		36	06.13		26	26.96	do	Do.
Ellis Cliff.....		24	19.86		26	58.17	do	Do.
Elysian Fields.....		37	21.58		24	22.72	do	Do.
Fairchild.....		41	39.86		23	14.21	do	Do.
Faucett.....		37	40.79		27	09.59	do	Do.
Ferguson.....		19	20.55		30	59.18	do	Do.
Ford.....		27	30.24		30	16.29	do	Do.
Forman.....		50	08.46		13	48.62	do	Do.
Gaither (or Gaither, 2).....		33	01.10		26	47.59	do	Do.
Gold Bottom.....		54	34.07		12	34.26	do	Do.
Harper.....		23	24.82		29	55.30	do	Do.
Hutchin Landing, Government light.....		24	22.32		27	09.76	do	Do.
Island.....		09	21.98		36	52.88	do	Do.
Ivanhoe.....		28	31.22		30	11.91	do	Do.
Jackson.....		16	02.50		35	31.66	do	Do.
Do.....		15	58.65		36	17.59	do	Do.
Gin.....		16	04.98		36	12.52	do	Do.
Kienstra.....		13	31.23		36	23.92	do	Do.
Chimney.....		13	39.34		36	23.84	do	Do.
Lower store.....		13	17.58		36	14.82	do	Do.
Upper store.....		13	33.71		36	23.59	do	Do.
Lemley.....		30	00.35		29	38.55	do	Do.
Leonard.....		23	09.30		31	44.53	do	Do.
Loch Seven.....		10	15.20		36	45.61	do	Do.
Gin.....		10	27.06		36	29.83	do	Do.
Landing.....		10	07.72		36	49.78	do	Do.
Lookout.....		33	12.15		26	41.28	do	Do.
Do.....		33	12.15		25	10.76	do	Do.
Minor.....		31	01.78		29	02.11	do	Do.
Natchez:								
Astronomical station, transit of 1878.....		33	27.16		24	05.20	do	Do.
Catholic church spire cross.....		33	28.70		24	06.75	do	Do.
Page.....		25	40.84		28	47.63	do	Do.
Palmetto.....		21	00.15		32	00.02	do	Do.
Palo Alto (or Palo Alto, 2).....		34	46.02		25	09.80	do	Do.
Peach Grove.....		11	35.34		35	49.78	do	Do.
Point.....		16	09.55		36	25.05	do	Do.
Quitman.....		40	37.87		22	56.52	do	Do.
Riverside, chimney.....		03	18.97		30	46.10	do	Do.
Rock Hill.....		02	09.86		33	20.32	do	Do.
Rodney.....		51	14.86		12	26.35	do	Do.
St. Catharine.....		26	13.22		29	49.03	do	Do.
Sandy Point.....		53	44.86		13	43.19	do	Do.
Saunders.....		58	40.26		08	23.30	do	Do.
Service.....		47	06.89		21	59.94	do	Do.
Shields.....		25	12.65		29	47.96	do	Do.
Government light near.....		25	19.17		30	16.12	do	Do.
Spithead.....		49	23.56		18	01.30	do	Do.
Stamp.....		06	49.74		36	00.20	do	Do.
Strothers.....		18	42.59		30	54.58	do	Do.
Surgett.....		24	20.02		28	48.14	do	Do.
Tarbert.....		00	21.36		35	59.96	do	Do.
House.....		01	14.69		35	20.65	do	Do.
Stable.....		00	57.96		35	29.52	do	Do.
Tall Pine.....		26	07.65		26	05.19	do	Do.
Ville.....		18	01.73		30	53.00	do	Do.
Walton, gin chimney.....		20	23.07		32	13.48	do	Do.
Waveland.....		58	02.29		09	43.67	do	Do.
Whitehall chute.....		59	56.94		07	22.34	do	Do.
Wilson.....		43	34.95		22	58.45	do	Do.
Winn.....		17	25.64		30	59.52	do	Do.
Wood yard, house chimney.....		16	21.25		34	30.09	do	Do.

LOUISIANA.

Name.	Latitude.	Longitude.	Authority.	Reference.
	32°-33°	90°-91°		
	° ' "	° ' "		
Crane.....	32 20 36.30	90 57 57.10	Miss. R. C	Rept. '87.
Last.....	15 53.70	57 47.92	do	Do.
Mattingly.....	20 44.06	59 05.67	do	Do.
North Bedford.....	15 23.65	57 09.72	do	Do.
Reade.....	16 48.24	57 41.30	do	Do.
South Bedford.....	14 39.35	57 38.20	do	Do.
Williams.....	19 52.64	58 09.23	do	Do.
	32°-33°	91°-92°		
	° ' "	° ' "		
Airlie.....	32 37 55.65	91 09 30.26	do	Do.
Arlington.....	48 25.27	09 44.64	do	Do.
Ashton.....	59 40.32	13 00.20	do	Do.
Bass.....	42 53.97	04 54.08	do	Do.
Biggs.....	17 54.94	57 27.43	do	Do.
Broozowski (Dr.), house chimney.....	23 41.46	00 55.48	do	Do.
Byrne.....	27 09.22	04 25.47	do	Do.
Church spire.....	37 05.13	04 26.90	do	Do.
Concord.....	42 17.66	06 01.28	do	Do.
Coons.....	11 38.08	02 12.91	do	Do.
Cottonwood.....	54 06.62	05 10.95	do	Do.
Gin chimney.....	53 16.30	06 05.50	do	Do.
Crandall.....	01 44.04	05 35.00	do	Do.
Creswell.....	29 53.90	07 32.67	do	Do.
Deer.....	44 29.05	05 23.12	do	Do.
Diamond.....	44 21.86	06 14.23	do	Do.
Diamond Island.....	13 45.91	01 25.52	do	Do.
Disharoon.....	01 00.44	06 16.25	do	Do.
Dillon.....	28 53.47	07 01.71	do	Do.
Edgewood.....	37 08.71	07 57.08	do	Do.
Elton.....	50 01.32	08 42.65	do	Do.
Gin gable.....	50 08.90	08 59.17	do	Do.
Middle dormer window.....	49 58.44	09 07.30	do	Do.
Exern.....	43 53.73	08 27.68	do	Do.
Foster.....	36 01.69	03 14.00	do	Do.
Gin cupola.....	36 49.75	05 05.21	do	Do.
Chimney.....	36 57.97	05 08.19	do	Do.
Friedlander.....	58 54.92	13 25.38	do	Do.
Goodrich, Odd Fellows' hall, north gable.....	37 41.51	00 14.05	do	Do.
Grace's store, west gable.....	57 35.12	04 35.22	do	Do.
Graves, house, center.....	27 24.31	04 34.68	do	Do.
Goza.....	57 58.55	12 51.92	do	Do.
Hardin.....	57 50.40	08 47.84	do	Do.
Hard Times.....	02 38.27	07 14.25	do	Do.
Henderson.....	35 00.07	04 12.74	do	Do.
Gin chimney.....	34 27.93	05 05.12	do	Do.
Hollow Ridge, church spire.....	51 15.68	05 48.01	do	Do.
Homestead.....	41 38.96	08 17.27	do	Do.
Homochitto.....	52 12.27	05 26.26	do	Do.
Illawana post-office, chimney.....	38 24.19	09 02.19	do	Do.
Imboden's store, chimney.....	59 28.44	13 09.57	do	Do.
Kellogg.....	11 06.11	01 44.75	do	Do.
Knight.....	00 23.85	07 52.03	do	Do.
Lake.....	25 58.43	02 01.88	do	Do.
Lake Providence:				
Base, north end.....	48 02.49	10 26.85	do	Do.
Base, south end.....	47 12.12	10 21.35	do	Do.
Longwood.....	51 30.85	07 10.50	do	Do.
Gin chimney.....	51 52.34	08 25.90	do	Do.
Mayer.....	25 24.56	02 11.02	do	Do.
McCullough's east chimney.....	53 10.92	05 54.92	do	Do.
Miliken's Bend, church spire.....	27 30.88	06 07.63	do	Do.
Moore.....	12 31.37	03 07.41	do	Do.
Morancy.....	27 56.91	06 08.45	do	Do.
Morency's house, northeast chimney.....	28 14.48	06 25.70	do	Do.
Munce.....	06 07.52	03 44.83	do	Do.
Myers's store, south chimney.....	37 48.80	03 00.16	do	Do.
Newman.....	37 01.53	03 44.87	do	Do.
Nichols.....	21 48.94	00 09.37	do	Do.
Old River.....	09 06.86	02 16.60	do	Do.
Omega.....	31 02.06	07 28.69	do	Do.
Owen's store, chimney.....	57 40.03	11 24.89	do	Do.
Pilcher's Point.....	57 43.94	11 25.28	do	Do.
Point Lookout.....	43 36.00	04 41.33	do	Do.
Point Pleasant.....	07 53.77	04 42.77	do	Do.
Possum Point.....	57 10.85	06 40.40	do	Do.
Chimney.....	57 05.60	06 33.24	do	Do.
Raleigh.....	36 56.27	05 58.39	do	Do.
River Light.....	55 28.31	04 14.88	do	Do.
Scott.....	57 41.44	08 00.48	do	Do.
Small house, west gable.....	55 27.65	04 14.52	do	Do.
Stamboul.....	40 31.33	09 54.43	do	Do.

LOUISIANA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	32°-33°	91°-92°		
	° ' "	° ' "		
Terrapin	32 32 58.21	91 06 01.35	Miss. R. C	Rept. '87.
Utz	23 03.09	00 58.41	do	Do.
Villa Vista	34 13.50	05 22.02	do	Do.
Vista	52 37.63	06 15.04	do	Do.
Gin chimney	52 11.34	06 53.72	do	Do.
Wilkinson	10 21.81	01 20.27	do	Do.
Wilson	03 46.77	07 35.78	do	Do.
Wilson's Point	56 03.14	05 20.33	do	Do.
Gin chimney	55 42.84	05 26.80	do	Do.
Wilton	39 24.57	10 23.39	do	Do.
Wyly	45 24.16	10 05.91	do	Do.
Wyly's house, east gable	45 23.44	10 26.13	do	Do.
	31°-32°	91°-92°		
	° ' "	° ' "		
Ashley	31 25 48.00	91 31 15.46	do	Do.
Gin chimney	26 11.13	31 29.94	do	Do.
(Below) Government light	24 33.86	31 05.13	do	Do.
Ballamagan	06 46.76	36 45.05	do	Do.
Black Hawk	09 23.57	37 34.04	do	Do.
Gin	09 32.43	37 50.68	do	Do.
Bondurant	56 33.20	11 03.84	do	Do.
Bougere	16 42.70	36 58.09	do	Do.
Chimney	16 44.87	36 53.99	do	Do.
Gin	16 48.41	36 53.20	do	Do.
Bullock	37 33.69	28 57.89	do	Do.
Cabin	15 32.76	38 12.69	do	Do.
Canebrake	42 00.20	24 09.95	do	Do.
Connor	37 51.44	25 35.93	do	Do.
Conti	30 14.55	30 31.04	do	Do.
Coochee	05 42.17	36 23.84	do	Do.
Crothers	28 26.02	31 44.18	do	Do.
House chimney	28 47.63	31 01.03	do	Do.
(North of) smokestack	28 43.86	31 08.80	do	Do.
(Near) ginhouse stack	28 10.96	31 21.33	do	Do.
(North of) belfry	28 42.74	31 10.38	do	Do.
CXI Bar	50 28.38	14 19.93	do	Do.
Davis	39 46.75	23 37.62	do	Do.
Down-river, dovecot	28 46.92	30 58.17	do	Do.
Esperance	25 00.35	28 47.88	do	Do.
Fairview	24 27.65	31 54.01	do	Do.
Fairview Landing, river front of new store.	19 49.76	31 51.22	do	Do.
Fritz	16 58.51	31 52.29	do	Do.
Gillespie	55 14.20	12 53.00	do	Do.
Glasscock	21 00.48	33 37.95	do	Do.
Golman	48 55.29	21 18.77	do	Do.
Goodhope	38 17.82	27 20.68	do	Do.
Hard Scrabble	58 50.95	09 02.30	do	Do.
Harpers Island	50 31.62	16 01.82	do	Do.
Hole in Wall	43 13.71	24 09.46	do	Do.
Home Place	16 19.66	33 47.93	do	Do.
Store gable	16 22.29	33 48.08	do	Do.
Kemps Landing	49 47.47	19 44.54	do	Do.
Kers Point	00 49.32	36 47.88	do	Do.
Langside :				
Chimney	01 58.56	34 44.22	do	Do.
Gin	01 46.27	34 40.29	do	Do.
L'Argent	44 28.46	23 42.49	do	Do.
Lees Point	51 06.88	13 15.05	do	Do.
Lewis	52 24.36	14 22.01	do	Do.
Lum	02 52.85	34 44.81	do	Do.
Lums Point, base :				
Southwest end, astronomical station.	02 29.11	35 17.08	do	Do.
Northeast end	03 13.73	34 26.42	do	Do.
McElroy	16 10.43	31 43.27	do	Do.
Moro	29 10.85	30 40.38	do	Do.
Natchez	31 25.99	30 20.20	do	Do.
Natchez Island, Government light	30 14.07	30 30.86	do	Do.
Obers	18 49.54	31 42.21	do	Do.
Gin chimney	18 28.02	32 26.78	do	Do.
Pecan	14 54.47	38 04.35	do	Do.
Do	24 21.73	30 30.91	do	Do.
Point Breeze	04 15.82	33 45.78	do	Do.
Pullen	09 56.98	37 33.25	do	Do.
Race course	45 59.34	22 44.55	do	Do.
Roseland	20 05.55	32 21.10	do	Do.
Gin chimney	19 27.26	31 50.03	do	Do.
Rosenthal	22 48.93	34 11.85	do	Do.
Store, river end	23 51.54	33 24.82	do	Do.
St. Joseph	54 04.73	14 20.91	do	Do.
Shamrock	40 30.20	23 44.48	do	Do.

LOUISIANA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	31°-32°			91°-92°				
	°	'	"	°	'	"		
Tower.....	31	13	04.87	91	37	35.91	Miss. R. C.	Rept. '87.
Tregar.....		00	15.26		37	32.29	do	Do.
Union Point.....		13	33.23		37	07.33	do	Do.
Gin.....		12	51.92		37	43.16	do	Do.
Up-river, dovecot.....		28	47.87		30	57.94	do	Do.
Vancluse.....		38	43.86		23	55.90	do	Do.
Vidalia:								
West end base.....		36	04.48		26	24.01	do	Do.
Do.....		35	01.02		26	24.01	do	Do.
East end base.....		33	42.59		25	18.00	do	Do.
Warnicott.....		27	15.89		31	15.25	do	Do.
(Near) gin chimney.....		27	09.40		31	40.96	do	Do.
Waterloo, 2.....		36	19.80		28	41.39	do	Do.
Waterproof.....		48	05.39		22	56.59	do	Do.
Watson.....		55	42.60		11	58.96	do	Do.
Whitehall.....		32	23.44		28	31.19	do	Do.
Wilds.....		16	30.13		35	07.85	do	Do.
	30°-31°			90°-91°				
Anderson.....	30	04	09.38	90	54	48.47	do	Do.
Sugarhouse chimney.....		03	31.15		55	04.63	do	Do.
Ashland, sugarhouse chimney.....		10	59.90		59	14.96	do	Do.
Bowden.....		09	39.47		59	40.71	do	Do.
Sugarhouse chimney.....		09	36.64		59	01.07	do	Do.
Brand, sugarhouse chimney.....		06	00.47		54	05.02	do	Do.
Brulé, sugarhouse chimney.....		08	31.54		53	15.42	do	Do.
Burnside.....		09	52.19		55	55.82	do	Do.
Clark pump chimney.....		08	12.41		55	25.68	do	Do.
Cofield, sugarhouse chimney.....		07	53.23		55	58.42	do	Do.
Colomb, bagasse burner.....		04	30.60		50	46.33	do	Do.
Conway, sugarhouse chimney.....		09	10.86		54	41.79	do	Do.
Donaldson, sugarhouse chimney.....		09	03.97		55	58.42	do	Do.
Donaldsonville:								
Baptist church.....		06	11.54		59	18.79	do	Do.
Methodist church.....		06	15.28		59	25.48	do	Do.
Cross on convent.....		06	14.36		59	05.47	do	Do.
Cupola of Lemann's block.....		06	25.81		59	13.37	do	Do.
Catholic church, east tower.....		06	18.05		58	58.25	do	Do.
Base, north end.....		06	11.22		57	54.89	do	Do.
Base, south end.....		04	23.90		58	10.57	do	Do.
Dugas, sugarhouse, east chimney.....		05	55.55		58	11.01	do	Do.
Garnier, bagasse burner.....		03	23.15		52	32.56	do	Do.
Hampton.....		05	12.13		53	07.46	do	Do.
Hermitage, sugarhouse chimney.....		06	59.43		57	48.23	do	Do.
Houmas, sugarhouse chimney.....		07	27.27		54	26.23	do	Do.
Ice factory, chimney.....		06	16.71		58	30.70	do	Do.
Lauderdal, sugarhouse chimney.....		04	28.03		55	10.87	do	Do.
Leblanc:								
Bagasse burner.....		04	59.64		55	41.57	do	Do.
Sugarhouse, south chimney.....		07	46.75		59	34.41	do	Do.
Lemann.....		06	30.61		55	39.23	do	Do.
Sugarhouse chimney.....		05	49.57		59	01.67	do	Do.
Minlor, sugarhouse chimney.....		04	47.63		52	02.99	do	Do.
Nelmo.....		57	51.60		15	25.67	do	Do.
New Hope, sugarhouse chimney.....		03	24.54		53	01.37	do	Do.
Orange Grove, sugarhouse chimney.....		08	50.20		53	54.00	do	Do.
Rapidan, sugarhouse chimney.....		04	38.26		52	24.02	do	Do.
Riverton.....		08	37.55		57	21.76	do	Do.
Sugarhouse chimney.....		08	57.16		56	51.38	do	Do.
St. Ann's chapel.....		09	06.78		59	42.17	do	Do.
St. Mary's, church cross.....		05	17.96		54	17.33	do	Do.
St. Victoria, bagasse burner.....		03	15.69		54	17.09	do	Do.
Salsbury, sugarhouse chimney.....		05	19.42		55	20.60	do	Do.
Scanlon, sugarhouse chimney.....		06	12.30		54	09.49	do	Do.
Stella, sugarhouse chimney.....		05	37.09		57	29.10	do	Do.
Tureaud.....		07	35.43		54	10.85	do	Do.
Texas.....		10	26.44		58	16.78	do	Do.
Trist, sugarhouse chimney.....		04	30.21		53	01.65	do	Do.
Union, sugarhouse chimney.....		06	40.08		54	14.94	do	Do.
Wallace, sugarhouse chimney.....		05	39.89		57	58.33	do	Do.
Whitehall, sugarhouse chimney.....		04	42.21		53	37.38	do	Do.
Winchester, sugarhouse chimney.....		03	03.34		54	51.18	do	Do.
	30°-31°			91°-92°				
Acklin.....	30	56	05.52	91	38	10.81	do	Do.
Adelard Landry, sugarhouse chimney.		10	02.25		00	48.96	do	Do.
Alexander Creek.....		45	28.23		22	22.78	do	Do.
Do.....		45	34.69		22	19.99	do	Do.
Allsworth.....		31	27.02		11	53.21	do	Do.
Anchorage.....		28	56.53		12	01.00	do	Do.
Sugarhouse chimney.....		29	00.32		12	19.57	do	Do.

LOUISIANA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	30°-31°			91°-92°				
	°	'	"	°	'	"		
Anger	30	17	26.38	91	10	03.83	Miss. R. C.	Rept. '87.
Angola		57	31.14		39	01.92	do	Do.
Arizona, sugarhouse :								
South chimney		13	16.99		05	03.88	do	Do.
North chimney		13	17.46		05	04.02	do	Do.
Arlington		23	47.41		12	49.12	do	Do.
Ashland, flagstaff		10	23.72		00	07.84	do	Do.
Australia		20	09.88		09	36.29	do	Do.
Sugarhouse chimney		19	57.03		09	30.35	do	Do.
Ayraud		05	44.77		02	27.88	do	Do.
Babina, sugarhouse chimney		29	48.08		15	36.50	do	Do.
Bagatelle, sugarhouse chimney		14	32.32		06	22.29	do	Do.
Bailey		19	22.87		11	09.83	do	Do.
Bar		30	54.46		16	25.59	do	Do.
Barrow		36	01.63		19	10.26	do	Do.
Barrow's chimney		47	39.47		31	31.60	do	Do.
Baton Rouge		26	19.00		11	26.42	do	Do.
Barracks, flagstaff		27	23.45		11	17.33	do	Do.
Astronomical and longitudinal station.		27	18.02		11	17.86	do	Do.
Barracks, astronomical azimuth station.		27	28.35		11	24.43	do	Do.
Methodist church spire		27	05.76		11	11.56	do	Do.
North end base		25	59.92		11	24.72	do	Do.
South end base		25	09.43		11	42.15	do	Do.
State penitentiary, round brick chimney.		27	04.21		10	55.59	do	Do.
State House, northwest tower		26	51.56		11	20.29	do	Do.
State University, pole on cupola		26	28.70		11	07.86	do	Do.
Batture		17	06.00		12	00.05	do	Do.
Bayou		28	28.01		11	31.79	do	Do.
Bayou Sara :								
Methodist church		46	08.34		23	40.59	do	Do.
Schoolhouse		46	04.52		23	28.22	do	Do.
Vane		45	58.17		23	35.43	do	Do.
Gin chimney		45	59.68		23	23.57	do	Do.
Colored church belfry		44	30.99		22	13.59	do	Do.
Belair		30	33.81		12	07.55	do	Do.
Sugarhouse, west chimney		30	29.34		12	25.29	do	Do.
Belle Vale		30	15.85		14	57.85	do	Do.
Belle Vale, sugarhouse chimney		30	15.11		14	50.12	do	Do.
Belle Grove		11	22.14		07	11.89	do	Do.
Sugarhouse chimney		11	06.52		06	55.59	do	Do.
Store, east gable		11	21.67		07	11.85	do	Do.
Belmont		30	40.21		14	02.45	do	Do.
Belmont, sugarhouse chimney		29	59.54		14	10.47	do	Do.
Bend		19	26.44		09	37.69	do	Do.
Bergeron		43	44.63		33	42.09	do	Do.
Big Cave		39	50.81		19	08.36	do	Do.
Bockel		44	32.88		27	12.90	do	Do.
Brulé Landing church		23	09.92		14	09.27	do	Do.
Bougeoir		47	15.11		32	24.97	do	Do.
Gin		46	42.34		35	31.13	do	Do.
Boulieu		25	19.51		12	39.53	do	Do.
Sugarhouse chimney		25	28.09		12	49.23	do	Do.
Bovard		45	06.40		23	58.07	do	Do.
House		45	01.58		23	42.73	do	Do.
Sugarhouse chimney		44	52.52		13	52.06	do	Do.
Brandon		50	59.61		31	07.40	do	Do.
Brown		36	26.05		18	08.19	do	Do.
Stable		36	36.95		17	49.82	do	Do.
Burnside, bagasse burner		08	34.94		02	02.71	do	Do.
Canty sawmill chimney		07	39.98		01	31.59	do	Do.
Cat Island		44	26.68		33	57.44	do	Do.
Celeste, sugarhouse chimney		11	29.94		06	19.47	do	Do.
Chamberlain		28	36.84		12	39.84	do	Do.
Do		32	09.03		17	30.01	do	Do.
Chataw, sugarhouse chimney		11	24.09		03	37.71	do	Do.
Chatworth		20	41.01		09	02.23	do	Do.
Sugarhouse chimney		20	53.56		08	36.12	do	Do.
Cheatham		55	19.37		36	09.66	do	Do.
Chinn		31	20.65		17	28.83	do	Do.
Church, near Evergreen		16	29.16		11	54.45	do	Do.
Cinclare		23	45.79		13	36.63	do	Do.
Stable lightning rod		23	49.57		13	52.33	do	Do.
Claiborne		11	58.70		04	12.19	do	Do.
Sugarhouse chimney		43	47.36		27	36.87	do	Do.
Do		11	50.01		04	33.92	do	Do.
Clark, sugarhouse chimney		33	14.51		17	28.76	do	Do.
Clarke		33	57.99		15	42.41	do	Do.
Clement		15	59.78		09	47.90	do	Do.

LOUISIANA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	30°-31°			91°-92°				
	°	'	"	°	'	"		
Coal yard	30	31	05.84	91	14	09.49	Miss. R. C	Rept. '87.
House		55	00.87		34	01.68	do	Do.
Colwell		30	33.08		16	28.16	do	Do.
Sugarhouse chimney		30	24.38		16	17.06	do	Do.
Como		54	30.03		31	53.17	do	Do.
Conrad		18	47.15		11	14.38	do	Do.
Cottage		21	15.31		13	24.29	do	Do.
Sugarhouse chimney		21	26.96		13	37.93	do	Do.
Cotton		49	07.71		31	51.78	do	Do.
Coulon		44	51.94		25	04.25	do	Do.
Crescent		05	17.78		00	20.80	do	Do.
Sugarhouse chimney		04	39.01		01	17.43	do	Do.
Cuba, sugarhouse chimney		11	04.48		02	05.35	do	Do.
Cut Off		55	32.44		37	10.20	do	Do.
Depot, astronomical station		45	52.73		23	18.45	do	Do.
Deserted Cabin		52	40.63		31	14.78	do	Do.
Devall		32	52.58		15	53.62	do	Do.
Dichary		08	23.93		00	31.02	do	Do.
Sugarhouse chimney		08	21.56		00	11.37	do	Do.
Douglas		51	19.84		31	42.77	do	Do.
Doyle's chimney		45	21.07		22	12.68	do	Do.
Duncan		22	07.16		13	55.90	do	Do.
Dupuy		14	42.93		06	42.57	do	Do.
Eastman		58	28.86		38	37.93	do	Do.
Elevator		40	19.62		17	21.84	do	Do.
Evan Hall		07	31.81		02	36.88	do	Do.
Sawmill chimney		07	18.64		02	08.51	do	Do.
Sugarhouse chimney		07	02.28		02	52.87	do	Do.
Evergreen		16	28.82		11	56.98	do	Do.
Fancy Point		40	33.13		19	53.08	do	Do.
Fairot		29	56.62		13	16.57	do	Do.
Ferry		27	10.10		12	01.52	do	Do.
Fisher		44	37.29		31	39.82	do	Do.
Fischer's Landing		47	18.95		34	54.17	do	Do.
Forlorn Hope, sugarhouse chimney		17	24.21		09	25.67	do	Do.
Fort		44	46.30		21	44.36	do	Do.
Frances Gomez, sugarhouse chimney		05	33.27		01	31.75	do	Do.
Gay		16	41.86		12	44.49	do	Do.
Gay's house, lightning rod		26	57.53		12	05.83	do	Do.
Gem, sugarhouse chimney		08	42.08		00	02.69	do	Do.
Glennon		35	16.58		18	48.99	do	Do.
Sugarhouse chimney		34	52.92		19	06.32	do	Do.
Golden Ridge		15	54.89		07	40.50	do	Do.
Gravel		35	30.46		18	06.96	do	Do.
Greenfield, sugarhouse chimney		16	01.09		10	15.40	do	Do.
Hard Times		31	13.33		12	32.88	do	Do.
Sugarhouse chimney		13	15.64		05	13.91	do	Do.
Hereford, sugarhouse chimney		34	16.74		18	27.54	do	Do.
Hicky		20	45.69		14	33.64	do	Do.
Hill		28	26.16		12	00.77	do	Do.
Hog Point		55	36.15		38	42.01	do	Do.
Hog Point Landing		55	50.73		39	00.81	do	Do.
Hollywood, bagasse chimney		21	15.40		10	38.58	do	Do.
Home Place, sugarhouse chimney		09	26.63		00	42.41	do	Do.
Hopkins		43	50.92		30	04.69	do	Do.
Horner		31	22.65		13	21.13	do	Do.
Indian Camp, sugarhouse chimney		11	52.54		07	29.41	do	Do.
Iron chimney		16	04.30		10	40.64	do	Do.
Keller		47	52.99		31	21.61	do	Do.
Kelson		36	45.92		18	44.59	do	Do.
Sugarhouse chimney		37	24.48		18	53.07	do	Do.
Kingsbury		57	27.87		39	45.24	do	Do.
Store		57	24.57		39	46.00	do	Do.
Knox		29	17.00		11	35.75	do	Do.
Labry		42	43.71		21	14.69	do	Do.
Last		34	42.00		16	00.57	do	Do.
Leblanc		07	15.14		00	14.10	do	Do.
Lebret		42	50.09		20	43.24	do	Do.
Leonard		45	12.47		34	55.45	do	Do.
Leperre, sugarhouse chimney		20	28.83		13	11.89	do	Do.
Letherman		54	35.69		33	05.17	do	Do.
Levert		15	52.79		07	23.58	do	Do.
Lieux sawmill		41	31.87		21	05.07	do	Do.
Light-house:								
(Near Chatworth)		20	24.40		08	36.98	do	Do.
(Near Hicky, removed April, 1880)		20	56.19		14	35.79	do	Do.
(Near Woodland)		18	26.28		13	55.02	do	Do.
Limerick		26	09.88		12	12.40	do	Do.
Sugarhouse, north chimney		26	07.17		12	21.85	do	Do.
Sugarhouse, south chimney		26	06.64		12	21.91	do	Do.
Lobdell		34	35.90		17	52.48	do	Do.

LOUISIANA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	30°-31°			91°-92°				
	°	'	"	°	'	"		
Long Wood	30	39	57.43	91	18	28.22	Miss. R. C	Rept. '87.
Lopez		21	02.41		11	36.36	do	Do.
McCallum's Point		44	10.05		35	46.40	do	Do.
McManner :								
Sawmill chimney		07	44.22		02	11.55	do	Do.
Sugarhouse chimney		07	42.49		02	40.30	do	Do.
McWilliams house lightning rod		19	08.34		12	33.79	do	Do.
Magee		45	50.00		24	09.77	do	Do.
Manchac		18	59.06		08	51.13	do	Do.
Sugarhouse chimney		18	42.30		08	23.10	do	Do.
Martin		20	21.73		12	11.45	do	Do.
Maryland		12	33.13		06	15.49	do	Do.
Medora		19	07.26		12	35.95	do	Do.
Miles chimney		55	16.66		38	21.88	do	Do.
Miles Point		55	12.25		37	29.08	do	Do.
Missouri		22	19.99		14	33.54	do	Do.
Modeste, sugarhouse chimney		10	23.42		01	07.85	do	Do.
Monte Sano		30	38.62		11	35.42	do	Do.
Monticello		15	38.53		06	25.64	do	Do.
Morganza		44	11.35		34	46.12	do	Do.
Morrison, sugarhouse chimney		43	28.40		31	37.67	do	Do.
Mount Houmas, sugarhouse chimney		12	11.88		00	41.51	do	Do.
Mount Houmas house, south gable		11	44.14		01	12.85	do	Do.
Mount Pleasant		38	14.70		17	52.34	do	Do.
Stable		38	33.40		17	30.79	do	Do.
Landing		38	32.16		17	45.62	do	Do.
Gin		38	33.64		17	38.13	do	Do.
Mulberry Grove, sugarhouse chimney		21	15.55		09	54.95	do	Do.
Neal		46	33.43		34	41.99	do	Do.
Negro church or school		35	14.20		18	59.80	do	Do.
New House		47	21.04		31	47.90	do	Do.
New Texas		46	54.01		35	13.49	do	Do.
Gin chimney		46	13.00		35	34.22	do	Do.
Chimney		46	10.77		35	38.08	do	Do.
Flagstaff		46	28.15		35	28.61	do	Do.
Quitman statue		46	26.20		35	25.66	do	Do.
Nina, sugarhouse chimney		40	57.64		21	04.74	do	Do.
Oaks, sugarhouse, south chimney		26	50.13		12	19.40	do	Do.
Ober gin		46	28.13		35	35.80	do	Do.
Ohlivalla, sugarhouse chimney		10	41.37		07	35.26	do	Do.
Old Hickory, sugarhouse chimney		11	53.94		05	22.71	do	Do.
Old River		54	48.88		36	29.97	do	Do.
Old River House		54	48.63		36	36.54	do	Do.
One Hundred Mile, sugarhouse chimney		14	28.77		06	36.03	do	Do.
Ophelia		13	04.60		08	08.43	do	Do.
Palo Alto		14	10.26		08	04.73	do	Do.
Sugarhouse chimney		05	37.30		02	23.93	do	Do.
Pederre overseer's house		43	43.58		28	53.75	do	Do.
Pelico, sugarhouse chimney		09	07.75		01	19.13	do	Do.
Plaquemine		17	17.12		13	36.61	do	Do.
Catholic church spire		17	31.97		14	02.85	do	Do.
Point		31	24.19		16	50.51	do	Do.
Do		18	05.54		13	24.99	do	Do.
Point Coupee base :								
Southeast end		44	49.20		22	35.00	do	Do.
Do		44	55.65		22	32.22	do	Do.
Northwest end		45	08.63		23	24.03	do	Do.
Point Pleasant		15	22.95		06	51.73	do	Do.
Pole		27	17.86		11	23.43	do	Do.
Poplar		29	21.20		13	52.09	do	Do.
Poplar Grove, sugarhouse chimney		29	26.77		12	24.08	do	Do.
Porche		43	10.87		21	21.56	do	Do.
Port Hudson		40	27.00		17	54.10	do	Do.
Sawmill		40	36.66		17	20.56	do	Do.
Port Manoir		39	50.66		17	58.96	do	Do.
Powell		44	05.82		21	21.56	do	Do.
Proctor chimney		54	47.88		36	07.07	do	Do.
Profit Island		34	56.93		17	50.14	do	Do.
Raccourci Point		47	58.12		32	00.93	do	Do.
Ralston		35	24.70		27	06.86	do	Do.
Randolph, sugarhouse chimney		35	24.28		19	16.57	do	Do.
Red River		58	50.28		39	08.54	do	Do.
School		58	11.06		39	58.86	do	Do.
Light		58	35.32		39	26.16	do	Do.
Warehouse		58	00.20		39	50.16	do	Do.
Red Store		44	03.49		27	00.30	do	Do.
Rescue		12	58.45		04	35.72	do	Do.
Sugarhouse chimney		13	10.88		04	28.91	do	Do.
Revenue, sugarhouse chimney		13	32.40		03	58.18	do	Do.
Rews Ditch		47	41.24		33	44.22	do	Do.

LOUISIANA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	30°-31°			91°-92°				
	°	'	"	°	'	"		
Reynaud	30	34	17.51	91	16	05.26	Miss. R. C	Rept. '87.
Rifle Point		37	58.53		24	58.77	do	Do.
Riley		34	57.47		16	49.10	do	Do.
Riverlight		12	57.41		04	47.57	do	Do.
Rivers		23	39.08		33	19.45	do	Do.
Gin chimney		24	30.72		33	36.30	do	Do.
R. O. Landry, sugarhouse chimney ..		08	56.24		01	36.25	do	Do.
Rome		06	46.50		00	56.81	do	Do.
Rouzan, sugarhouse chimney		20	30.97		08	05.19	do	Do.
Rowe		55	30.09		34	04.47	do	Do.
St. Bernard		55	03.43		34	09.18	do	Do.
St. Francis church		44	52.08		24	56.27	do	Do.
St. Francisville :								
Catholic church cross		46	26.82		23	25.55	do	Do.
Episcopal church		46	32.40		23	14.55	do	Do.
St. Gabriel church		15	19.86		06	24.33	do	Do.
St. Martin		09	15.71		02	03.15	do	Do.
St. Maurice		43	44.87		28	42.96	do	Do.
St. Peter's and St. Paul's church ..		30	16.74		15	11.93	do	Do.
Sandy Point		40	13.41		19	16.45	do	Do.
School		14	53.98		07	14.93	do	Do.
Schultz		47	12.33		33	36.52	do	Do.
Shaw		47	37.58		32	38.51	do	Do.
Shelton		41	32.96		20	30.05	do	Do.
Slaughter		39	56.26		17	23.56	do	Do.
Small house, chimney		18	48.66		09	19.62	do	Do.
Smith chimney		55	52.05		39	03.62	do	Do.
Smithland gin		55	44.87		39	06.17	do	Do.
Solitude		34	29.05		16	50.45	do	Do.
Southwood		13	26.81		03	04.90	do	Do.
Sugarhouse chimney		13	19.56		02	54.08	do	Do.
Souvenir, sugarhouse chimney		06	45.94		01	51.94	do	Do.
Springfield		33	54.83		15	02.51	do	Do.
Star, sugarhouse chimney		14	49.26		06	25.28	do	Do.
Stevenson		52	32.03		31	41.39	do	Do.
Stewart, sugarhouse chimney		43	43.50		31	55.75	do	Do.
Stump		53	59.06		32	25.84	do	Do.
Swamp		30	56.46		14	56.65	do	Do.
Taylor		43	39.89		21	33.21	do	Do.
Sugarhouse chimney		44	04.34		22	02.19	do	Do.
Thomas		32	31.95		15	36.48	do	Do.
Thompson		44	31.96		22	04.28	do	Do.
Tonliet, sugarhouse chimney		20	25.26		11	44.48	do	Do.
Tregars chimney		59	27.59		38	40.74	do	Do.
Tunica Island		49	18.49		31	14.57	do	Do.
Tunica Landing		55	15.19		33	01.72	do	Do.
Van Winkle		40	02.06		20	23.82	do	Do.
Van Winkle B. B.		39	20.57		20	43.16	do	Do.
Ventress		16	50.81		08	24.25	do	Do.
Vignes		45	10.06		35	26.43	do	Do.
Sugarhouse chimney		42	25.00		21	25.10	do	Do.
Viola		31	02.33		13	10.14	do	Do.
Vohn's, sugarhouse chimney		24	20.19		13	35.33	do	Do.
Von Pool		29	25.04		12	02.07	do	Do.
Wade		52	39.77		31	13.56	do	Do.
House		52	57.11		31	19.58	do	Do.
Shed		52	27.49		31	07.38	do	Do.
Waterloo		41	18.99		20	57.75	do	Do.
Church		40	48.87		21	40.44	do	Do.
Sugarhouse chimney		12	42.28		01	19.16	do	Do.
Store		41	50.56		21	08.12	do	Do.
Wick's, sugarhouse chimney		25	32.16		11	03.26	do	Do.
Wild Wood		38	18.60		18	21.21	do	Do.
Sawmill		38	15.63		18	25.75	do	Do.
Willow Bar		45	20.07		25	21.34	do	Do.
Willow Glen		16	14.30		07	02.23	do	Do.
Winter		32	04.12		16	30.43	do	Do.
Sugarhouse chimney		36	43.60		19	02.95	do	Do.
Woodland		18	25.28		13	58.40	do	Do.
Woods		20	24.97		10	49.80	do	Do.
Woodstock, sugarhouse chimney ..		10	28.12		01	20.51	do	Do.
Woodyard		44	12.22		28	47.20	do	Do.
Yale, sugarhouse chimney		10	46.66		01	47.86	do	Do.
	29°-30°			90°-91°				
Caillon	29	05	41.59	90	31	41.30	C. & G. S	
Calumet		06	12.59		20	58.79	do	
George		06	33.82		15	09.27	do	
James		06	22.18		24	11.10	do	
Tape		08	43.01		31	33.49	do	
Terrebonne		06	30.08		28	19.86	do	
Timballier light-house (1887)		03	06.01		20	57.38	do	

TEXAS.

Name.	Latitude.	Longitude.	Authority.	Reference.
	33°-34°	99°-100°		
	° / "	° / "		
Haskell.....	33 09 31.57	99 43 54.96	G. S.	Bull. 122.
Swinson.....	00 56.10	59 34.60	do	Do.
	3°3-34°	100°-101°		
Lem.....	33 03 59.68	100 26 11.37	do	Do.
	32°-33°	96°-97°		
Branden.....	32 40 47.93	96 54 56.48	do	Do.
Caruth.....	51 44.85	46 23.42	do	Do.
Ross.....	47 19.39	39 49.01	do	Do.
	32°-33°	97°-98°		
Boons.....	32 55 12.22	97 16 38.17	do	Do.
Bosque.....	07 32.51	46 44.20	do	Do.
Box.....	15 11.92	16 57.74	do	Do.
Boyles.....	39 48.57	43 43.31	do	Do.
Caddo Peak.....	29 00.39	24 27.05	do	Do.
Centipede.....	36 32.51	12 07.25	do	Do.
Comanche.....	22 38.19	47 59.00	do	Do.
Duffau.....	09 36.80	59 24.87	do	Do.
Estelle.....	53 44.08	06 34.46	do	Do.
Gatewood.....	06 04.59	40 45.05	do	Do.
Gathings.....	10 16.44	14 28.25	do	Do.
Harrison.....	48 18.01	53 38.28	do	Do.
Hart.....	19 09.35	32 52.02	do	Do.
Hix.....	03 43.68	20 01.32	do	Do.
Knisely.....	01 16.18	42 49.30	do	Do.
Levy.....	53 50.54	42 36.74	do	Do.
McIver.....	09 10.70	51 03.25	do	Do.
Myers.....	20 07.12	36 41.29	do	Do.
O'Neal.....	43 17.38	07 59.43	do	Do.
Post Oak.....	41 45.52	16 30.30	do	Do.
Rattlesnake.....	48 05.84	38 32.84	do	Do.
Slipdown.....	56 44.38	54 39.80	do	Do.
Turner.....	09 58.97	05 58.61	do	Do.
Widow.....	26 17.43	01 24.99	do	Do.
	32°-33°	98°-99°		
Black Jack.....	32 57 15.29	98 51 18.72	do	Do.
Bluff.....	55 35.49	18 02.09	do	Do.
Brazos.....	54 29.77	30 09.01	do	Do.
Breckenridge.....	48 03.95	49 51.89	do	Do.
Cisco.....	22 04.81	56 19.87	do	Do.
Astronomical pier.....	23 31.45	58 55.56	do	Do.
Cleveland.....	39 12.25	41 26.88	do	Do.
Corbin.....	43 47.07	17 52.54	do	Do.
Double Mountain.....	35 06.69	55 05.25	do	Do.
Guthrie.....	19 19.02	22 38.75	do	Do.
Ioni.....	41 51.43	27 25.52	do	Do.
Jameson.....	17 40.67	29 27.79	do	Do.
Kyle.....	49 24.60	19 08.23	do	Do.
Lost.....	02 41.87	54 53.40	do	Do.
McClenny.....	27 09.30	11 22.81	do	Do.
McDaniel.....	17 09.56	49 47.97	do	Do.
Murphy.....	18 32.64	13 19.65	do	Do.
Price.....	12 58.07	21 36.91	do	Do.
Thurman.....	40 59.96	35 53.02	do	Do.
	32°-33°	99°-100°		
Abilene.....	32 26 51.39	99 44 39.80	do	Do.
Anson.....	45 29.54	53 43.33	do	Do.
Buffalo.....	19 07.47	52 08.98	do	Do.
Cobb.....	36 00.71	29 11.90	do	Do.
Cottonwood.....	13 41.10	09 10.76	do	Do.
Eagle.....	10 21.65	49 45.86	do	Do.
East base.....	39 17.06	11 56.21	do	Do.
Flat Top.....	51 20.75	05 39.68	do	Do.
Hitson.....	28 42.69	18 50.74	do	Do.
Irving.....	59 33.38	10 19.31	do	Do.
Jones.....	12 01.65	56 43.69	do	Do.
Knoll.....	44 20.15	18 48.62	do	Do.
Lidel.....	15 26.24	40 48.20	do	Do.
Monroe.....	50 51.24	24 09.62	do	Do.
New.....	47 28.06	12 14.84	do	Do.
Sand.....	42 15.90	52 40.50	do	Do.
Stewart.....	42 44.26	25 11.16	do	Do.
Table Gap.....	01 23.63	46 54.52	do	Do.
Tarantula.....	58 20.32	34 21.57	do	Do.
Wesly.....	27 43.99	01 26.22	do	Do.
	32°-33°	100°-101°		
Ash.....	32 43 49.63	100 06 19.79	do	Do.
Austin.....	00 40.36	27 34.69	do	Do.
Bitter.....	19 55.64	16 37.63	do	Do.

TEXAS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	32°-33°	100°-101°		
	° ' "	° ' "		
Fence.....	32 26 40.88	100 14 30.05	G. S.....	Bull. 122.
Flint.....	07 48.41	02 41.19	do.....	Do.
Goat.....	00 56.09	36 27.63	do.....	Do.
Rusticus.....	12 39.04	15 12.15	do.....	Do.
Sweetwater.....	28 31.23	24 24.09	do.....	Do.
Sykes.....	17 29.43	23 42.72	do.....	Do.
Wasp.....	34 11.27	26 36.03	do.....	Do.
Jacksonville:	31°-32°	95°-96°		
Astronomical station.....	31 57 49.70	95 16 16.80	C. & G. S.....	
Methodist spire.....	57 37.91	16 20.03	do.....	
Presbyterian spire.....	57 40.47	16 07.57	do.....	
	31°-32°	97°-98°		
Adams.....	31 53 31.39	97 43 23.58	G. S.....	Do.
Doty.....	56 23.59	51 41.64	do.....	Do.
Frazier.....	59 31.22	04 44.75	do.....	Do.
Ghent.....	19 18.01	19 08.22	do.....	Do.
Kellum.....	48 45.07	27 16.61	do.....	Do.
Kendrick.....	29 37.62	14 18.50	do.....	Do.
Lynch.....	12 29.66	20 19.08	do.....	Do.
Mount Taylor.....	04 54.52	57 45.14	do.....	Do.
Nick.....	43 19.10	28 53.50	do.....	Do.
Simpson.....	36 08.95	29 26.69	do.....	Do.
West.....	48 22.07	05 47.56	do.....	Do.
Wind Mill.....	26 01.94	30 02.20	do.....	Do.
	31°-32°	98°-99°		
Station D.....	31 04 09.80	98 39 45.30	do.....	Do.
Thompson.....	55 13.70	53 40.90	do.....	Do.
Waters Mountain.....	05 31.20	20 27.60	do.....	Do.
	31°-32°	99°-100°		
Ballinger.....	31 44 24.92	99 56 40.24	do.....	Do.
Bones.....	00 31.31	39 17.61	do.....	Do.
Bradley.....	48 43.66	41 25.84	do.....	Do.
Live Oak.....	17 15.82	39 28.17	do.....	Do.
Maddox.....	04 19.66	46 12.14	do.....	Do.
Molloy.....	17 20.35	51 21.63	do.....	Do.
Mustang.....	02 34.52	56 00.35	do.....	Do.
Plateau.....	37 41.66	55 39.75	do.....	Do.
Rough.....	55 20.70	36 44.93	do.....	Do.
	31°-32°	100°-101°		
Ashurst.....	31 48 42.42	100 40 01.30	do.....	Do.
Bolt.....	08 19.11	50 47.98	do.....	Do.
Cedar.....	45 18.85	19 36.94	do.....	Do.
Concho.....	47 19.71	49 10.33	do.....	Do.
Dove.....	11 49.51	37 38.05	do.....	Do.
Dry.....	34 21.54	53 50.27	do.....	Do.
Edith.....	53 37.40	39 52.57	do.....	Do.
Flower.....	05 35.80	05 09.43	do.....	Do.
Funk.....	31 20.22	48 47.32	do.....	Do.
Gunny.....	30 03.10	38 58.62	do.....	Do.
Hayrick.....	59 29.96	20 48.70	do.....	Do.
Keith.....	11 54.22	13 44.55	do.....	Do.
Lake.....	52 13.50	46 01.34	do.....	Do.
Lipan.....	14 17.14	19 20.68	do.....	Do.
Lopez.....	20 40.27	51 04.44	do.....	Do.
Napp.....	46 37.47	43 00.86	do.....	Do.
Robert Lee.....	53 39.29	29 03.87	do.....	Do.
San Angelo.....	27 51.31	26 16.06	do.....	Do.
Water Valley.....	37 47.51	45 15.85	do.....	Do.
	31°-32°	104°-105°		
Diablo.....	31 11 50.54	104 54 52.40	do.....	Do.
El Capitan.....	53 26.38	51 39.69	do.....	Do.
	31°-32°	105°-106°		
Arispe.....	31 09 11.33	105 17 00.09	do.....	Bull. 70.
Cerro Alto.....	56 39.90	58 15.05	do.....	Bull. 122.
East base.....	04 54.70	09 32.38	do.....	Bull. 70.
Mesa.....	07 16.43	09 12.38	do.....	Do.
Quitman.....	08 56.68	29 48.26	do.....	Bull. 122.
Salt.....	34 40.74	08 51.69	do.....	Do.
Sierra Blanca.....	15 05.34	26 09.64	do.....	Do.
Astronomical pier.....	10 27.64	21 24.96	do.....	Bull. 70.
Taff.....	12 28.86	17 25.68	do.....	Do.
West base.....	06 35.65	13 03.41	do.....	Do.
Yucca.....	06 40.08	20 51.72	do.....	Do.
	31°-32°	106°-107°		
El Paso, Fort Bliss, astronomical monument.....	31 45 31.00	106 29 05.00	Wheeler.....	Rept. '79.
Graveyard Hill.....	45 52.00	29 41.00	do.....	Do.

TEXAS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	31°-32°	106°-107°		
	° ' "	° ' "		
North Franklin.....	31 54 07.24	106 29 35.83	G. S.....	Bull. 122.
South Franklin Mountain.....	48 15.00	28 47.00	Wheeler.....	Rept. '79.
	30°-31°	97°-98°		
Bald Knob.....	30 20 05.87	97 35 23.54	G. S.....	Bull. 122.
Bastrop Hill.....	07 38.30	18 35.30	do.....	Do.
Beaver Hill.....	42 25.88	33 52.51	do.....	Do.
Cedar Hill.....	11 21.78	57 08.14	do.....	Do.
Corn Hill.....	47 16.37	37 15.18	do.....	Do.
Haley Ratlif.....	53 41.15	43 52.40	do.....	Do.
Haystack.....	35 02.56	41 00.60	do.....	Do.
Hill.....	11 48.34	36 32.72	do.....	Do.
Land office.....	16 19.93	44 13.02	do.....	Do.
Lone Tree, 1.....	19 17.54	48 29.95	do.....	Do.
Morrison Ridge.....	45 19.74	50 42.37	do.....	Do.
Pilot Knob.....	09 29.83	42 20.80	do.....	Do.
P. K. N.....	27 15.59	42 07.64	do.....	Do.
Prairie, 2.....	51 14.17	57 33.71	do.....	Do.
Texas Hill.....	08 35.36	32 09.60	do.....	Do.
West base.....	12 15.17	42 56.82	do.....	Do.
Yegua Knob.....	20 31.99	11 20.30	do.....	Do.
	30°-31°	98°-99°		
Bachelor Peak.....	30 59 39.33	98 05 42.00	do.....	Do.
Bell Mountain.....	26 47.45	43 00.12	do.....	Do.
Bontlinghouse.....	33 37.40	05 19.93	do.....	Do.
Bunker Hill.....	56 22.45	17 33.60	do.....	Do.
House Mountain.....	35 33.74	55 08.09	do.....	Do.
Lone Man.....	04 35.92	05 11.12	do.....	Do.
Long Mountain.....	53 52.98	20 09.43	do.....	Do.
Riley Mountain.....	40 07.12	36 18.32	do.....	Do.
Roper Hill.....	46 17.52	16 11.78	do.....	Do.
Round.....	27 11.52	21 57.88	do.....	Do.
Shingle.....	18 12.80	05 38.58	do.....	Do.
Shovel.....	26 30.19	14 46.10	do.....	Do.
Station B.....	54 38.67	52 43.77	do.....	Do.
Station E.....	13 40.14	26 32.70	do.....	Do.
	30°-31°	100°-101°		
Black.....	30 49 00.64	100 18 24.99	do.....	Do.
Burbank.....	47 08.23	04 54.00	do.....	Do.
Cactus.....	48 55.20	55 40.13	do.....	Do.
Decker.....	39 40.12	07 33.92	do.....	Do.
Deer.....	43 24.69	58 22.66	do.....	Do.
Fawn.....	18 24.18	17 28.67	do.....	Do.
Fire.....	05 08.67	15 50.98	do.....	Do.
First.....	54 07.25	05 59.39	do.....	Do.
Fort McKavett.....	49 44.07	06 30.69	do.....	Do.
Harris.....	10 05.90	10 47.16	do.....	Do.
Jasper.....	00 26.69	14 16.28	do.....	Do.
Marshall.....	21 42.64	12 06.09	do.....	Do.
Patterson.....	25 35.59	02 23.80	do.....	Do.
Peak.....	45 21.64	41 42.07	do.....	Do.
Piner.....	32 52.64	12 28.28	do.....	Do.
Riley.....	38 41.06	14 59.28	do.....	Do.
Runge.....	51 35.49	46 26.47	do.....	Do.
Sumac.....	43 14.84	48 53.68	do.....	Do.
Wallace.....	16 00.33	27 18.40	do.....	Do.
Wentworth.....	26 34.59	20 38.55	do.....	Do.
Wolf.....	03 41.97	21 55.55	do.....	Do.
	30°-31°	103°-104°		
Mount Ord.....	30 14 23.04	103 30 56.05	do.....	Do.
Star.....	46 36.32	47 40.23	do.....	Do.
	30°-31°	104°-105°		
Baldy.....	30 38 05.85	104 10 26.27	do.....	Do.
Chispa.....	48 07.73	42 36.10	do.....	Do.
Meridian signal.....	59 51.56	59 56.49	do.....	Bull. 70.
Newman.....	59 58.36	04 45.31	do.....	Bull. 122.
Vieja.....	27 07.33	40 42.70	do.....	Do.
	30°-31°	105°-106°		
Eagle.....	30 55 14.41	105 05 08.13	do.....	Do.
	29°-30°	98°-99°		
Twin Sisters.....	29 58 48.70	98 26 40.50	do.....	Do.
	29°-30°	100°-101°		
Anacacho.....	29 11 12.82	100 17 10.78	do.....	Do.
Cline.....	12 07.36	08 28.00	do.....	Do.
Ellis.....	46 21.43	28 11.65	do.....	Do.
Fort Clark.....	18 27.65	25 08.14	do.....	Do.
Goode.....	44 56.80	17 24.28	do.....	Do.
Holliday.....	54 15.25	19 01.08	do.....	Do.

TEXAS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	29°-30°			100°-101°				
	°	'	"	°	'	"		
Las Moras	29	21	31.62	100	23	13.43	G. S	Bull. 122.
Monte		33	46.53		12	02.84	do	Do.
Nueces		37	33.84		19	51.26	do	Do.
Reagan		44	56.45		11	27.54	do	Do.
Spofford, water tank		10	31.91		24	32.72	do	Do.
Turkey		22	30.25		11	55.82	do	Do.
	29°-30°			103°-104°				
San Jacinto	29	45	12.59	103	57	19.11	do	Do.
Santiago		50	04.66		24	59.26	do	Do.
	29°-30°			104°-105°				
Chinati	29	57	09.32	104	28	41.05	do	Do.

ARKANSAS.

	36°-37°			91°-92°				
	°	'	"	°	'	"		
Salem	36	22	33.15	91	51	51.75	G. S	Bull. 122.
	36°-37°			92°-93°				
Alpha	36	13	01.65	92	06	48.75	do	Do.
Matny		12	18.70		18	57.43	do	Do.
Pilot		05	33.37		01	19.18	do	Do.
Pine, 2		24	47.43		40	42.55	do	Do.
Wallace Knob		21	23.63		22	37.71	do	Do.
	36°-37°			93°-94°				
Boat	36	07	33.17	93	02	09.29	do	Do.
Bread		34	45.63		28	47.28	do	Do.
Kennedy		14	24.06		13	31.11	do	Do.
Lead		25	50.96		00	52.38	do	Do.
Pyron		23	35.29		32	08.61	do	Do.
Sugar		27	36.37		53	48.00	do	Do.
Swain		17	23.38		45	52.65	do	Do.
Watson		15	00.09		28	21.56	do	Do.
	36°-37°			94°-95°				
Kestler	36	01	00.91	94	13	11.84	do	Do.
Orchard		09	59.74		04	32.59	do	Do.
Rogers		19	53.30		06	43.29	do	Do.
Twin		08	42.54		22	42.02	do	Do.
	35°-36°			90°-91°				
Appersen	35	06	51.50	90	10	07.14	Miss. R. C	Rept. '88.
Collins		01	32.71		17	33.87	do	Do.
East base		08	26.40		09	11.98	do	Do.
Fleece		03	11.19		10	11.52	do	Do.
Harris		02	13.13		12	47.81	do	Do.
Jones		05	25.92		10	33.06	do	Do.
Mathews		04	00.11		10	51.94	do	Do.
Mound City		10	39.88		06	29.73	do	Do.
Reeves		03	04.37		11	35.77	do	Do.
Scanlon		02	08.14		16	14.26	do	Do.
West base		08	09.59		10	36.53	do	Do.
	35°-36°			91°-92°				
Cedar	35	56	30.75	91	49	24.90	G. S	Bull. 122.
Deane		44	34.43		44	24.55	do	Do.
Mount Etna		52	32.89		45	07.36	do	Do.
	35°-36°			92°-93°				
Black	35	32	43.48	92	40	47.05	do	Do.
Blue		52	14.86		21	51.18	do	Do.
Brush		49	03.11		36	52.05	do	Do.
Bumrow		09	31.11		43	28.65	do	Do.
Cox		03	50.10		14	56.57	do	Do.
Evans		29	25.31		51	19.02	do	Do.
Finch		46	32.23		10	42.94	do	Do.
Fourche		01	01.68		50	55.13	do	Do.
Hump		20	23.13		13	17.40	do	Do.
Irons Point		51	30.69		01	04.50	do	Do.
Pig		17	40.98		32	22.09	do	Do.
Pine Hill		38	06.80		41	20.52	do	Do.
Point Pisgah		07	29.37		29	16.62	do	Do.
Pond		41	32.08		11	27.52	do	Do.
Raspberry		39	42.89		57	49.34	do	Do.
Red Hill		43	30.27		30	59.57	do	Do.
Reeves		43	31.74		44	17.74	do	Do.
Round, 2		50	26.51		56	23.41	do	Do.
Walker		40	13.08		51	46.06	do	Do.
Walnut		39	08.44		30	30.08	do	Do.

ARKANSAS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	35°-36°			93°-94°				
	°	'	"	°	'	"		
Bunker Hill	35	03	10.25	93	19	48.41	G. S.	Bull. 122.
Hobbs		54	04.07		59	23.90	do	Do.
Magazine		09	57.63		38	41.72	do	Do.
Spring		12	42.00		19	36.80	do	Do.
	35°-36°			94°-95°				
Boston	35	47	37.74	94	10	03.95	do	Do.
Cane Hill		54	32.67		27	53.07	do	Do.
Cartright		42	00.22		08	46.89	do	Do.
Drake		57	41.53		31	16.56	do	Do.
Fort Smith		23	14.65		25	52.35	do	Do.
Lee		37	42.12		21	58.45	do	Do.
Lockard		39	37.70		15	09.63	do	Do.
Peak		04	22.98		22	22.85	do	Do.
Pinnacle		12	45.51		03	12.44	do	Do.
Skylight		50	02.13		32	30.28	do	Do.
Sloane		51	26.29		09	14.99	do	Do.
Strickler		47	44.26		20	16.53	do	Do.
Wakefield		44	14.02		02	28.69	do	Do.
	34°-35°			90°-91°				
Abbison	34	22	41.73	90	41	46.12	do	Do.
Adams		34	13.68		33	58.61	Miss. R. C.	
Alderson		19	22.63		44	32.04	G. S.	Do.
Allen		12	51.70		54	08.13	do	Do.
Arbuckle		20	12.28		44	57.00	do	Do.
Ashley		45	48.88		26	53.09	Miss. R. C.	Rept. '87.
Baldwin		47	08.52		27	26.50	do	Do.
Basket		51	10.55		23	54.75	do	Do.
Beith Point		05	30.72		55	07.37	do	Rept. '82.
Berry		39	30.58		30	51.23	do	Rept. '87.
Blue Point		50	19.13		25	45.71	do	Do.
Black Oak		01	34.13		03	23.82	do	Rept. '82.
Bordeaux Island		45	48.85		30	22.77	do	Rept. '87.
Buckshot		35	32.69		33	15.48	do	Rept. '82.
Burtnett		03	12.58		54	13.97	do	Do.
Castile		23	17.62		43	15.05	do	Do.
Cat Island		55	31.59		15	55.39	do	Rept. '87.
Chute		57	17.51		16	04.78	do	Do.
Clack		45	09.20		27	39.33	do	Do.
Craig		24	19.19		37	30.66	do	Rept. '82.
Chute of 70		00	44.10		57	52.10	do	Do.
Dixie Landing		15	05.59		53	45.14	do	Do.
Fairview		59	11.84		17	37.76	do	Rept. '87.
Favorite Chute		44	56.19		31	12.88	do	Do.
Fort Penny		23	21.61		38	22.27	do	Rept. '82.
Fowler		07	29.61		56	53.18	do	Do.
Gillem		13	39.39		55	28.03	do	Do.
Graddys		01	05.73		02	09.50	do	Do.
Hackler		51	35.65		20	20.91	do	Rept. '87.
Hard Luck		02	44.85		55	39.03	do	Rept. '82.
Hardin Point		40	13.21		29	11.78	do	Rept. '87.
Helena		31	08.06		35	15.09	do	Rept. '82.
Helena Island No. 2		34	40.65		32	21.91	do	Do.
Horner		36	31.37		35	10.09	do	Rept. '87.
Hughey		16	09.25		48	57.54	do	Rept. '82.
Island 62		18	09.59		45	22.38	do	Do.
Island 63		17	30.48		45	39.10	do	Do.
Island 67		08	56.54		57	11.68	do	Do.
Island 68		08	30.47		56	30.04	do	Do.
Jacks		11	10.44		52	52.80	do	Do.
Jackson		40	25.02		33	30.04	do	Rept. '88.
Kangaroo Point		22	16.17		40	17.72	do	Rept. '82.
Knowlton		09	50.51		54	09.39	do	Do.
Laconia		02	20.86		56	25.74	do	Do.
Lotta		38	50.76		35	08.41	do	Rept. '88.
Ludlow		11	32.62		54	28.03	do	Rept. '82.
Malloy		14	49.02		50	09.87	do	Do.
Minork		06	29.50		56	13.29	do	Do.
Mohawk		09	16.51		52	12.17	do	Do.
Modoc		17	28.13		47	52.86	do	Do.
McCullom		20	53.26		45	20.01	do	Do.
McConnell		57	58.73		16	28.55	do	Rept. '88.
Oliver		09	28.04		50	58.24	do	Rept. '82.
Paroquet		17	48.95		46	35.64	do	Do.
Peters		48	47.25		27	42.03	do	Rept. '88.
Porter Lake		52	08.18		19	17.04	do	Do.
Prairie		35	37.18		34	04.13	do	Do.
Prewitt		21	50.94		45	18.85	do	Rept. '82.
Quaw		27	29.65		34	52.57	do	Do.
Rogers		43	45.82		31	50.45	do	Rept. '88.

ARKANSAS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	34°-35°	90°-91°		
	° / "	° / "		
St. Francis	34 40 00.08	90 31 43.83	Miss. R. C	Rept. '88.
St. Louis Landing	11 18.35	51 49.86	do	Rept. '82.
Sterling	37 27.75	35 34.87	do	Rept. '88.
Tow Head	17 59.77	44 19.60	do	Rept. '82.
West base	39 10.54	32 25.40	do	Rept. '88.
Westover	22 55.12	39 15.24	do	Rept. '82.
Walnut Bend	42 52.44	31 23.23	do	Rept. '88.
Wardell	39 24.73	28 59.63	do	Do.
Warfield	01 52.15	57 09.66	do	Rept. '82.
Williamson	29 32.37	35 27.48	do	Do.
Zenor	09 54.94	56 19.41	do	Do.
	34°-35°	91°-92°		
Foot of 70	34 00 10.06	91 00 49.71	do	Do.
Henley	00 44.49	04 41.86	do	Do.
Scrub Grass	00 17.90	03 46.25	do	Do.
	34°-35°	92°-93°		
Big Rock	34 46 17.88	92 17 55.49	G. S	Bull. 122.
Blocher	40 12.75	50 32.26	do	Do.
East base	44 09.15	10 24.73	do	Do.
Granite	41 11.10	17 30.50	do	Do.
Maumelle	50 25.22	29 09.79	do	Do.
Moss Mountain	49 53.56	40 13.42	do	Do.
Post-office	44 47.83	16 25.36	do	Do.
Reynolds	58 28.95	28 17.66	do	Do.
Shinall	47 51.69	29 49.62	do	Do.
West base	45 19.09	13 33.32	do	Do.
Warsaw	56 33.48	08 52.12	do	Do.
	34°-35°	93°-94°		
Allen	34 51 06.10	93 28 14.79	do	Do.
Muddy	46 06.63	31 57.82	do	Do.
Powell	46 01.91	20 45.57	do	Do.
Round	44 00.72	44 55.63	do	Do.
Smith	46 11.34	01 49.01	do	Do.
Whiteoak	58 41.14	56 41.10	do	Do.
	34°-35°	94°-95°		
Black Fork	34 42 39.78	94 22 05.39	do	Do.
Blue	41 07.21	02 53.18	do	Do.
East Poteau	58 32.51	09 30.16	do	Do.
Poteau, 2	57 42.39	22 31.33	do	Do.
	33°-34°	91°-92°		
Adams	33 12 35.70	91 06 03.33	Miss. R. C	Rept. '88.
Arkansas River	48 41.21	04 22.02	do	Rept. '82.
Arkansas City	36 06.49	12 31.35	do	Do.
Bachelors Bend, tow-head	23 35.23	05 34.93	do	Rept. '88.
Barnard	05 54.40	10 35.21	do	Do.
Betsley	59 01.89	04 09.20	do	Rept. '82.
Bradley	57 22.66	03 09.49	do	Do.
Brooks	09 09.00	09 28.35	do	Rept. '88.
Cane	43 35.28	10 56.80	do	Rept. '82.
Cassell	59 49.91	04 52.14	do	Do.
Catfish Tow-head	40 41.36	08 30.06	do	Do.
Chicora	40 28.00	12 24.65	do	Do.
Chicot	38 55.47	10 58.84	do	Do.
Cook	40 25.69	05 04.81	do	Do.
Coryes	42 27.28	04 45.30	do	Do.
Cracraft's gin, southeast gable	03 50.50	09 45.19	do	Do.
Cumbyville	54 07.09	03 57.62	do	Do.
Cypress Creek	43 13.16	11 48.85	do	Do.
Davis	18 55.89	11 00.65	do	Do.
Deadwood	43 12.05	06 55.94	do	Do.
Drift	10 27.90	05 26.45	do	Rept. '88.
Duffin	35 24.94	13 20.47	do	Rept. '82.
Eunic	32 23.38	12 45.58	do	Do.
Frank, J	53 14.11	03 52.27	do	Do.
Ford	08 49.85	07 53.74	do	Rept. '88.
Gaines Landing	27 51.90	14 28.68	do	Rept. '82.
Good Luck	43 10.75	09 31.84	do	Do.
Goose Bar	15 21.19	07 40.25	do	Rept. '88.
Graves	00 58.81	09 53.22	do	Do.
Store, northeast chimney	02 16.91	09 42.48	do	Do.
Haley	08 25.73	11 08.73	do	Do.
Halliday	22 26.22	07 48.58	do	Do.
Harwood	09 18.91	06 37.96	do	Do.
Harwood's store, chimney	09 39.42	06 11.70	do	Do.
Harwood, white house, southeast chimney	09 40.42	06 28.32	do	Do.
Hawkins	09 48.23	06 05.91	do	Do.
Hayden	42 42.45	05 53.93	do	Rept. '82.
Hill's chimney	07 49.20	08 44.99	do	Rept. '88.

ARKANSAS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	33°-34°			91°-92°				
	°	'	"	°	'	"		
Hilliard	33	04	54.70	91	10	05.42	Miss. R. C.	Rept. '88.
Hilliard's pigeon house		04	50.91		10	06.37	do	Do.
Hilliard's store chimney		04	52.10		10	06.00	do	Do.
Hunting Lodge		03	15.94		09	48.94	do	Do.
Island 78		36	46.27		09	44.39	do	Rept. '82.
Island 83		25	20.40		03	58.47	do	Do.
Jersey Point		40	57.39		07	15.36	do	Do.
Junction		13	20.01		07	00.70	do	Rept. '88.
Lakeport		13	37.43		07	31.09	do	Do.
Lands End		59	15.90		00	17.07	do	Rept. '82.
Leland		21	41.85		09	09.44	do	Do.
Longwood:								
Gin chimney		09	26.64		04	37.49	do	Rept. '88.
Warehouse gable		09	15.33		05	18.64	do	Do.
Marengo, gin chimney		05	54.88		11	29.23	do	Do.
Middle Ground		50	05.95		03	28.32	do	Rept. '82.
Melona		51	29.22		03	07.89	do	Do.
Mitchell		39	41.03		11	46.10	do	Do.
Montgomery		58	06.02		03	32.66	do	Do.
Moore		07	32.10		11	51.06	do	Rept. '88.
Mud Creek		28	38.13		14	17.93	do	Rept. '82.
Napoleon		47	45.35		04	33.45	do	Do.
North Choctaw		38	20.50		09	56.12	do	Do.
Oak Landing		44	08.01		08	29.53	do	Do.
Old Town		22	55.91		44	25.92	do	Do.
Ozart		45	56.60		06	32.98	do	Do.
Palmetto		33	16.62		13	24.13	do	Do.
Panther Forest		26	47.53		12	28.68	do	Do.
Point Chicot		24	44.14		05	24.84	do	Rept. '88.
Tow Head		26	04.00		05	06.98	do	Rept. '82.
Point Comfort		28	40.47		10	40.46	do	Do.
Point Cook		41	29.00		03	53.80	do	Do.
Raft		11	42.42		05	34.81	do	Rept. '88.
Raynor		03	59.84		09	34.36	do	Do.
Rowdy Bend		26	50.95		13	41.37	do	Rept. '82.
Russett		42	00.01		02	53.33	do	Do.
Sabenden		41	20.95		12	38.08	do	Do.
Sibley		56	25.35		03	00.68	do	Do.
Scott		27	29.08		11	23.08	do	Do.
South Choctaw		37	21.02		09	19.52	do	Do.
Starling		16	46.24		08	29.68	do	Rept. '88.
Sterling		02	02.89		09	36.32	do	Do.
Stevenson		00	09.42		11	05.68	do	Do.
Sunnyside		17	31.73		09	22.35	do	Do.
Thorn Point		46	38.45		05	20.47	do	Rept. '82.
Turner		40	17.03		06	17.35	do	Do.
Vancluse		20	27.64		10	32.78	do	Rept. '88.
Wallwood		25	37.56		06	35.10	do	Rept. '82.
Warner		28	37.54		08	04.30	do	Do.
White Hill		36	24.25		11	19.67	do	Do.
White River		55	31.36		03	19.12	do	Do.
Whittaker		22	57.68		06	47.74	do	Rept. '88.
Wilkinson		42	09.15		08	10.34	do	Rept. '82.
Williams		45	15.51		08	37.61	do	Do.
Yellow Bend		34	16.41		13	46.24	do	Do.

INDIAN TERRITORY.

	35°-36°			94°-95°				
	°	'	"	°	'	"		
Cavanal	35	04	11.43	94	40	46.16	G. S.	Bull. 122.
North base		07	59.47		32	01.38	do	Do.
Poteau, 1		55	24.14		29	28.19	do	Do.
South base		05	47.52		33	23.98	do	Do.
Sugarloaf		01	31.49		28	07.04	do	Do.

TENNESSEE.

	36°-37°			82°-83°				
	°	'	"	°	'	"		
Bristol	36	35	49.00	82	11	13.00	C. & G. S.	Bull. 122.
Chimney Top		24	28.90		42	24.20	G. S.	
Holston		27	27.30		04	38.50	do	Do.
Roan		06	16.40		07	20.60	do	Do.

TENNESSEE—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	36°-37° ° / "	83°-84° ° / "		
House	36 06 42.90	83 45 59.90	G. S	Bull. 122.
McLean	28 19.80	55 47.50	do	Do.
Short	22 52.60	10 45.80	do	Do.
War Gap	30 14.70	01 38.00	do	Do.
	36°-37°	84°-85°		
Adkins	36 09 42.75	84 51 52.98	C. & G. S.	
Brushy	04 37.22	24 37.75	do	
Cross	11 55.20	13 52.30	do	Do.
Jellico	35 03.20	07 28.80	do	
	36°-37°	85°-86°		
Apple	36 10 48.51	85 48 09.98	do	
Walker	10 26.85	20 36.63	do	
	35°-36°	82°-83°		
Chucky	35 59 39.50	82 53 42.30	G. S	Do.
	35°-36°	83°-84°		
Chilhowee, 1	35 45 54.50	83 45 30.10	do	Do.
English	54 04.90	17 51.50	C. & G. S.	Do.
	35°-36°	84°-85°		
Hangover	35 23 11.70	84 58 08.16	do	
Chilhowee, 2	35 46.90	00 28.00	G. S	Do.
Chilhowee, 4	07 24.70	37 16.20	do	Do.
Guide	26 25.80	14 03.60	do	Do.
Hinch	46 53.10	58 42.80	do	Do.
Luper	57 16.39	47 20.17	do	
Melton	54 34.80	18 18.40	do	Do.
Owen	36 34.00	29 38.84	do	
Roy	31 27.60	26 46.30	G. S	Do.
Texas	19 31.70	54 38.40	do	Do.
	35°-36°	85°-86°		
Cardwell	35 40 59.82	85 40 47.61	C. & G. S.	
Grindstone	04 18.00	01 18.60	G. S	Do.
Harvey	23 33.10	17 44.90	do	Do.
Mount Love	54 57.71	32 26.12	C. & G. S.	
Short	52 14.78	58 22.44	do	Do.
	35°-36°	86°-87°		
Bennett	35 55 57.47	86 37 11.08	do	
Versailles	43 11.94	32 22.52	do	
	35°-36°	90°-91°		
Barton	35 12 16.53	90 06 03.23	Miss. R. C	Rept. '87.
Bayou	08 05.49	07 38.44	do	Do.
Cow Island	00 19.18	16 57.76	do	Do.
Bend	00 12.26	17 56.78	do	Do.
Crawford	06 54.00	08 23.68	do	Do.
Davis	07 05.13	06 46.91	do	Do.
Ensley	04 10.88	09 39.29	do	Do.
Forrest	06 41.10	05 20.36	do	Do.
Frame Chute	10 57.76	04 14.43	do	Do.
Hopefield	09 54.93	04 27.02	do	Do.
Horn Lake	01 19.59	12 30.17	do	Do.
Lake	07 41.73	09 18.49	do	Do.
Leadbetter	06 08.40	09 31.28	do	Do.
Memphis	08 39.00	03 15.45	C. & G. S.	Rept. '84.
Do	08 39.85	03 20.22	Miss. R. C	Rept. '87.
Do	08 38.60	03 16.50	L. S	Final Rept.
Do	08 37.50	03 17.40	do	Do.
Patterson	02 09.75	13 52.91	Miss. R. C	Rept. '87.
Peterson	07 46.06	04 15.11	do	Do.
Rock Chute	01 29.67	13 52.91	do	Do.
Vance, jr	07 39.56	05 37.57	do	Do.
Vance, sr	08 30.58	04 26.90	do	Do.
Wolf River	10 06.18	03 19.66	do	Do.
Watson	01 54.65	11 17.84	do	Do.

KENTUCKY.

	38°-39° ° / "	82°-83° ° / "		
Howland	38 37 47.18	82 59 20.14	C. & G. S.	Rept. '84.
Louisa transit	06 54.90	36 06.15	do	Do.
Buena Vista	23 44.10	48 21.47	do	
Oakland	21 46.55	38 52.70	do	
	38°-39°	83°-84°		
Cave	38 32 39.81	83 04 23.42	do	
Mount Sterling	03 28.40	55 50.90	G. S	Bull. 122.

KENTUCKY—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	38°-39° ° ' "	84°-85° ° ' "		
Falmouth	38 40 37.60	84 16 54.20	C. & G. S.	
Lexington College building	02 25.30	30 21.00	do	
	38°-39°	85°-86°		
Cox Knob	38 09 25.40	85 46 15.80	do	
Louisville	15 08.00	45 28.80	do	
Shelbyville	12 45.40	13 14.60	do	
	37°-38°	82°-83°		
Frazier	37 24 02.90	82 40 05.60	G. S.	Bull. 122.
Preston	46 57.30	55 11.60	do	Do.
Quicksand	29 03.30	55 46.20	do	Do.
Waseoto	06 44.80	43 54.00	do	Do.
Willard	15 35.30	22 59.90	do	Do.
Wolf	43 34.40	34 20.90	do	Do.
	37°-38°	83°-84°		
Ballard	37 55 18.40	83 42 23.10	do	Do.
Carr	14 29.20	05 33.50	do	Do.
Coburn	55 56.20	43 43.90	do	Do.
Cope	37 26.90	18 51.00	do	Do.
Gross	30 31.10	35 32.40	do	Do.
High Rocks	47 22.30	46 36.70	do	Do.
Hunter	23 10.00	46 20.60	do	Do.
High Knob	14 57.60	53 49.70	do	Do.
Hogtown	37 01.90	04 28.30	do	Do.
Nailor	27 49.50	24 58.00	do	Do.
Nelson	43 13.40	31 05.10	do	Do.
Orchard	08 35.20	44 05.80	do	Do.
Pilot	12 53.80	50 05.60	do	Do.
Raccoon	09 04.30	59 29.60	do	Do.
Rice	22 14.30	35 33.90	do	Do.
Rose	27 39.70	33 16.30	do	Do.
Turkey	27 16.30	44 26.80	do	Do.
Willoughby	55 39.80	53 07.60	do	Do.
	37°-38°	84°-85°		
Bear	37 32 08.90	84 15 21.30	do	Do.
Brushy	20 04.50	25 51.20	do	Do.
Green River	09 14.90	50 42.50	do	Do.
Lancaster	37 10.50	34 43.30	do	Do.
London	08 02.20	05 20.14	C. & G. S.	Rept. '84.
Richmond	44 30.40	18 02.64	G. S.	Bull. 122.
Central College	44 32.80	18 02.00	C. & G. S.	
Sand	31 12.40	52 08.90	G. S.	Do.
Stone quarry	37 56.20	02 33.10	do	Do.
	37°-38°	85°-86°		
Greensburg	37 15 38.30	85 29 56.40	C. & G. S.	
	37°-38°	86°-87°		
Oakland	37 02 27.50	86 15 18.20	do	Rept. '84.
	37°-38°	87°-88°		
Henderson	37 50 24.80	87 35 26.10	do	Do.
	37°-38°	88°-89°		
Paducah	37 04 59.20	88 35 56.10	do	Do.
	36°-37°	83°-84°		
Gray Knob	36 47 16.20	83 17 26.40	G. S.	Bull. 122.
Harlan	53 54.70	19 03.10	do	Do.
Longspur	56 22.40	02 30.50	do	Do.
Paint Gap	57 16.50	36 31.80	do	Do.
White Rocks	39 54.70	27 03.30	do	Do.
	36°-37°	84°-85°		
King	36 50 59.90	84 05 34.40	do	Do.
	36°-37°	87°-88°		
Guthrie	36 38 53.90	87 09 36.15	C. & G. S.	
	36°-37°	89°-90°		
Hickman	36 34 17.70	89 11 41.35	do	Rept. '84.

OHIO.

	41°-42° ° ' "	80°-81° ° ' "		
Andover	41 37 05.72	80 36 30.62	L. S.	Final Rept.
Ashtabula :				
Baptist church	52 02.70	47 01.60	do	Do.
Southwest corner passenger depot	52 36.13	47 38.55	do	Do.

OHIO—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	41°-42°	80°-81°		
	° ' "	° ' "		
Conneaut.....	41 53 52.58	80 36 51.56	C. & G. S.....	Final Rept.
Geneva.....	51 14.20	59 47.00	do.....	Do.
Saybrook.....	53 33.00	49 55.00	do.....	Do.
Mesopotamia.....	26 59.98	59 54.09	do.....	Do.
Berea:	41°-42°	81°-82°		
German Wallace College chapel spire.....	41 22 06.10	81 51 06.30	do.....	Do.
Stone Methodist church spire.....	21 46.70	51 12.50	do.....	Do.
Chester.....	32 02.88	21 17.20	do.....	Do.
Claridon.....	30 39.61	07 06.27	do.....	Do.
Cleveland:				
Light-house on high bank in city.....	30 06.13	42 13.20	do.....	Do.
Light-house.....	30 01.60	42 09.60	do.....	Do.
Euclid.....	35 37.30	33 05.20	do.....	Do.
Fairport:				
Light-house on bank.....	45 24.80	16 39.70	do.....	Do.
Light-house on pier.....	45 41.60	16 48.80	do.....	Do.
Grafton.....	12 44.21	59 37.85	do.....	Do.
Little Mountain.....	38 26.34	16 28.60	do.....	Do.
North Royalton:				
Stone Baptist church spire.....	18 53.60	44 10.70	do.....	Do.
Frame Methodist church, in northern part of town, spire.....	19 29.20	44 10.40	do.....	Do.
Olmstead.....	22 52.18	57 22.96	do.....	Do.
Painesville:				
Episcopal church (spire) on west side of State street.....	43 41.20	14 36.10	do.....	Do.
Spire brick Congregational church.....	43 26.00	14 44.30	do.....	Do.
Perry.....	48 04.70	08 55.60	do.....	Do.
Rockport.....	27 45.93	47 32.30	do.....	Do.
Royalton.....	19 29.89	44 10.65	do.....	Do.
Thompson.....	41 14.35	02 37.47	do.....	Do.
Warrensville.....	28 39.24	30 12.88	do.....	Do.
Willoughby.....	40 28.71	26 25.77	do.....	Do.
	41°-42°	82°-83°		
Black River light-house.....	41 28 23.90	82 11 08.30	do.....	Do.
Brownhelm.....	23 18.46	18 28.76	do.....	Do.
Camden.....	16 26.04	17 46.73	do.....	Do.
Cedar Point light-house.....	29 17.40	41 37.40	do.....	Do.
Danbury.....	31 11.94	50 20.30	do.....	Do.
East base.....	26 28.58	38 04.66	do.....	Do.
Elyria.....	24 55.41	08 44.06	do.....	Do.
Green Island light-house.....	38 43.90	52 04.10	do.....	Do.
Huron:				
Presbyterian church spire.....	23 42.60	33 21.00	do.....	Do.
Light-house.....	24 03.10	32 51.10	do.....	Do.
Kelley.....	36 17.77	41 45.29	do.....	Do.
Marblehead light-house.....	32 11.00	42 43.40	do.....	Do.
Middle base.....	41 47.87	47 15.12	do.....	Do.
Oberlin:				
Second Congregational church spire.....	17 28.90	13 10.50	do.....	Do.
Pointed tower at Union School building, South Main street.....	17 26.20	13 01.80	do.....	Do.
Point Pelee.....	48 50.72	41 02.55	do.....	Do.
Sandusky.....	24 34.43	45 02.76	do.....	Do.
Court-house.....	27 13.80	42 41.90	do.....	Do.
Townsend.....	15 43.48	29 00.63	do.....	Do.
Vermillion.....	25 12.70	21 59.40	do.....	Do.
West base.....	29 02.32	40 58.43	do.....	Do.
	41°-42°	83°-84°		
Cedar Point.....	41 42 37.77	83 20 06.66	do.....	Do.
Locust Point.....	36 54.83	06 21.38	do.....	Do.
Toledo:				
St. Mary's Catholic church spire.....	39 32.10	32 02.50	do.....	Do.
Astronomical station, 182 west and 188 north of stone marking intersection of Ontario and Mon- roe streets; stone, long post, of 1881.....	39 03.65	32 30.60	do.....	Do.
Turtle Island light-house.....	45 08.80	23 28.80	do.....	Do.
West Sister Island light-house.....	44 13.10	06 39.00	do.....	Do.
	39°-40°	82°-83°		
Columbus, transit.....	39 57 40.00	82 59 42.15	C. & G. S.....	Rept. '84.
	39°-40°	84°-85°		
Cincinnati.....	39 08 20.00	84 25 20.49	do.....	Do.
Mitchell's observatory (aban- doned).....	05 54.00	29 45.75	do.....	Do.

OHIO—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	38°-39° ° ' "	82°-83° ° ' "		
Fradd	38 35 47.00	82 33 05.85	C. & G. S.	Bull. 122.
Gould	38 27.64	49 56.46	do	Do.
South Point	25 14.00	35 26.00	do	Do.
Wray	35 42.32	27 38.71	do	Do.

INDIANA.

	41°-42° ° ' "	84°-85° ° ' "		
Fremont	41 42 32.09	84 57 58.97	L. S.	Final Rept.
NW. corner sec. 31, T. 38 N., R. 14 E.	42 55.90	58 16.00	do	Do.
Corner secs. 2, 3, 10, 11, T. 37 N., R. 6 E.	41 40 54.80	85 48 43.50	do	Do.
Jefferson	41 00.04	48 30.08	do	Do.
SW. corner NW. ¼ sec. 33, T. 38 N., R. 8 E.	42 16.10	37 13.60	do	Do.
Corner secs. 4, 5, 8, 9, T. 37 N., R. 11 E.	41 08.40	16 23.30	do	Do.
Lima, tower schoolhouse	43 30.70	25 13.60	do	Do.
Mongo	41 34.56	16 08.70	do	Do.
Van Buren	42 29.79	36 46.74	do	Do.
Carlisle	41 40 05.16	86 29 38.80	do	Do.
Galena	41 45.88	40 32.13	do	Do.
Michigan City	44 07.79	52 20.79	do	Do.
High school spire	42 51.80	53 47.60	do	Do.
Spire Lutheran church	42 45.40	53 59.60	do	Do.
Light-house	43 21.10	54 21.80	do	Do.
Otis	35 18.65	52 35.94	do	Do.
Penn	38 53.13	12 26.72	do	Do.
New Carlisle :				
Spire Christian church	42 22.30	30 41.90	do	Do.
Spire Methodist Episcopal church	42 25.70	30 40.80	do	Do.
South Bend :				
Standpipe	40 31.40	14 52.60	do	Do.
University dome	42 11.00	14 20.90	do	Do.
Springville	39 52.80	44 30.61	do	Do.
Corner secs. 17, 18, 19, 20, T. 37 N., R. 3 E.	39 04.40	12 57.30	do	Do.
Corner secs. 2, 3, 10, 11, T. 37 N., R. 1 W.	40 46.40	30 23.60	do	Do.
SW. corner SE. ¼ of SW. ¼ sec. 32, T. 38 N., R. 2 W.	41 39.00	40 33.40	do	Do.
SE. corner sec. 10, T. 37 N., R. 3 W.	39 52.20	44 19.70	do	Do.
NW. corner sec. 10, T. 36 N., R. 4 W.	35 32.80	52 39.00	do	Do.
Miller	41 36 55.42	87 14 18.63	do	Do.
SE. corner of NE. ¼ sec. 6, T. 36 N., R. 7 W.	36 05.10	15 40.50	do	Do.
SW. corner of SE. ¼ of SE. ¼ sec. 27, T. 7 N., R. 11 E.	39 01 00.87	85 16 59.40	C. & G. S.	Do.

ILLINOIS.

	42°-43° ° ' "	87°-88° ° ' "		
Benton	42 29 02.87	87 52 44.10	L. S.	Final Rept.
Deerfield	10 20.55	50 45.94	do	Do.
Evanston :				
Center tower of Northwest University.	03 06.50	40 34.20	do	Do.
SW. corner sec. 25, T. 41 N., R. 13 W.	00 40.60	49 34.40	do	Do.
Waukegan :				
Presbyterian church	21 41.40	50 03.30	do	Do.
Court-house	21 33.90	50 58.60	do	Do.
NW. corner sec. 6, T. 46 N., R. 12 E.	29 37.20	52 56.50	do	Do.
SE. corner sec. 24, T. 45 N., R. 11 E.	21 21.60	53 06.40	do	Do.
SW. corner sec. 28, T. 43 N., R. 12 E.	10 02.30	50 51.60	do	Do.
Park Ridge	00 58.27	49 40.50	do	Do.
Warren	21 26.58	53 23.14	do	Do.
Antioch	42 26 03.67	88 03 12.50	do	Do.
Clinton	29 39.34	52 01.15	C. & G. S.	Bull. 122.
Deans Corners, Congregational church.	16 38.50	02 41.30	L. S.	Final Rept.

ILLINOIS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43° ° ' "	88°-89° ° ' "		
Fremont	42 16 37.18	88 02 44.01	L. S.	Final Rept.
Palatine	07 02.94	02 26.62	do	Do.
Spire Methodist Episcopal church	06 46.20	02 37.40	do	Do.
High school building flagstaff	06 48.80	02 31.10	do	Do.
Rock church	22 04.81	56 38.03	C. & G. S.	
SW. corner sec. 14, T. 42 N., R. 10 E.	06 37.50	02 38.40	L. S.	Do.
SW. corner sec. 27, T. 46 N., R. 10 E.	25 47.80	03 45.80	do	Do.
	42°-43°	89°-90°		
Newark	42 29 55.62	89 12 36.97	C. & G. S.	
Rockton, church	27 23.19	04 15.41	do	
Roscoe, church	28 17.97	03 17.82	do	
State line No. 1	29 49.18	04 25.93	do	
Wadams Grove	24 58.94	52 02.53	do	
Warren	29 38.37	59 16.37	do	
	42°-43°	90°-91°		
Galena :	42 25 11.50	90 25 55.70	L. S.	Final Rept.
Northeast corner Methodist Episcopal church				
Intersection of fourth principal meridian with State line	30 26.10	25 33.60	do	Do.
Horseshoe Mound	24 31.56	23 59.71	C. & G. S.	
	41°-42°	87°-88°		
Chicago	41 50 01.00	87 50 26.78	L. S.	Do.
Tower of waterworks	53 49.80	37 28.30	do	Do.
Light-house	53 20.50	36 52.20	do	Do.
Do	53 22.49	36 48.90	do	Do.
Tall tower of Chicago University	49 58.60	36 45.20	do	Do.
Shot tower	53 11.42	38 30.13	do	Do.
Crete	24 53.57	38 40.50	do	Do.
Cyrus Township, SW. corner sec. 34, T. 38 N., R. 13 W.	43 56.40	51 27.10	do	Do.
Dalton, prominent brick chimney	38 59.20	17 08.40	do	Do.
East base	45 36.06	43 36.69	do	Do.
Frankfort :				
German Lutheran church	29 45.00	50 58.80	do	Do.
Flagstaff of elevator	29 55.50	51 00.80	do	Do.
Garden	26 24.48	49 35.93	do	Do.
Grant	14 50.04	38 49.45	do	Do.
Kankakee	07 06.19	51 40.58	do	Do.
High school building tower	07 06.20	51 40.60	do	Do.
Southwest corner of water table of court-house	07 09.00	51 38.80	do	Do.
First Baptist church spire	07 12.80	51 39.10	do	Do.
Lombard	54 07.79	59 25.02	do	Do.
Lyons Township, NE. corner sec. 13, T. 38 N., R. 13 W.	47 30.80	48 05.90	do	Do.
Manteno	14 54.96	50 07.43	do	Do.
Northeast corner Catholic church	14 48.80	50 12.50	do	Do.
Methodist church spire	15 09.00	50 16.60	do	Do.
Military Academy	41 21.85	40 32.96	do	Do.
Morgan Park	41 28.60	40 24.98	do	Do.
Baptist church	41 37.20	40 39.50	do	Do.
Orland	34 20.08	51 19.04	do	Do.
Palos Township :				
NW. corner sec. 3, T. 37 N., R. 13 W.	43 56.40	51 25.90	do	Do.
Center of sec. 13, T. 38 N., R. 13 W.	47 03.60	48 41.90	do	Do.
St. Anne	01 19.46	43 16.04	do	Do.
Catholic church spire	01 36.20	43 19.60	do	Do.
West base	47 03.40	48 40.33	do	Do.
Willow Springs	43 36.93	51 06.36	do	Do.
Do	43 38.63	51 06.75	do	Do.
Center of sec. 4, T. 39 N., R. 11 E.	53 49.50	59 19.40	do	Do.
Center of sec. 8, T. 30 N., R. 13 W.	05 55.80	51 34.40	do	Do.
Corner secs. 10, 11, 14, and 15, T. 34 N., R. 13 W.	26 27.00	49 33.00	do	Do.
Corner secs. 15, 16, 21, and 22, T. 32 N., R. 12 E.	15 01.90	50 19.50	do	Do.
Corner secs. 27, 28, 33, and 34, T. 36 N., R. 12 E.	34 20.10	51 06.70	do	Do.
NE. corner sec. 20, T. 32 N., R. 11 W.	15 07.30	37 33.30	do	Do.
NE. corner sec. 27, T. 38 N., R. 12 W.	45 50.80	43 21.00	do	Do.
NW. corner sec. 4, T. 39 N., R. 11 E.	54 18.40	59 54.00	do	Do.
SE. corner sec. 13, T. 37 N., R. 12 W.	41 30.50	40 52.40	do	Do.
SW. corner sec. 4, T. 29 N., R. 12 W.	01 15.40	43 56.80	do	Do.
SW. corner sec. 20, T. 34 N., R. 11 W.	24 47.50	38 05.06	do	Do.
	41°-42°	90°-91°		
Rock Island :	41 31 01.50	90 33 46.00	do	Do.
Southeast corner of guard-house	31 03.40	33 40.10	do	Do.
Astronomical post on U. S. Arsenal grounds				

ILLINOIS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	40°-41° ° ' "	87°-88° ° ' "		
Ash.....	40 35 18.36	87 47 49.98	L. S.....	Final Rept.
Butler.....	24 17.70	46 54.55	do.....	Do.
Clifton.....	56 14.29	56 16.74	do.....	Do.
Northeast corner Congregational church.	56 08.60	56 08.90	do.....	Do.
Schoolhouse tower.....	56 15.90	56 11.00	do.....	Do.
Fairmount.....	01 35.84	50 48.78	do.....	Do.
Methodist church spire.....	02 45.10	49 44.80	do.....	Do.
Baptist church spire.....	02 43.20	49 51.10	do.....	Do.
Hoopeston Methodist church spire.....	28 02.00	40 00.20	do.....	Do.
Pilot Grove.....	12 03.60	50 12.60	do.....	Do.
Spring Creek.....	40 00.18	59 30.11	do.....	Do.
Watseka.....	45 08.69	47 17.39	do.....	Do.
Court-house tower.....	46 28.90	44 09.00	do.....	Do.
Corner secs. 8, 9, 16, and 17, T. 20 N., R. 13 W.	12 07.10	50 45.00	do.....	Do.
Corner secs. 33 and 34, T. 29 N., R. 14 W.	56 35.80	56 36.50	do.....	Do.
NE. corner sec. 2, T. 26 N., R. 13 W.	46 19.00	47 11.50	do.....	Do.
NE. corner sec. 35, T. 25 N., R. 13 W.	35 19.70	47 07.30	do.....	Do.
SE. corner sec. 8, T. 18 N., R. 13 W.	01 35.30	50 37.10	do.....	Do.
SE. corner sec. 35, T. 27 N., R. 13 W.	46 19.00	47 12.50	do.....	Do.
SE. corner sec. 35, T. 23 N., R. 13 W.	24 05.00	45 46.80	do.....	Do.
SE. corner sec. 36, T. 23 N., R. 13 W.	24 05.70	45 39.00	do.....	Do.
SW. corner of SE. $\frac{1}{4}$ of sec. 31, T. 26 N., R. 14 W.	40 46.50	59 00.50	do.....	Do.
	40°-41°	88°-89°		
Champaign, Illinois Industrial University, center of east tower	40 06 33.10	88 13 38.50	do.....	Do.
Mayview.....	06 52.95	07 21.47	do.....	Do.
Paxton.....	26 40.47	02 08.20	do.....	Do.
Congregational church spire.....	27 37.70	06 00.80	do.....	Do.
Swedish Evangelical Lutheran church spire.	27 23.00	05 24.40	do.....	Do.
Rantoul.....	19 13.84	02 03.67	do.....	Do.
Steeple with cross.....	18 37.30	09 25.80	do.....	Do.
White steeple.....	18 41.70	09 33.60	do.....	Do.
Sydney, tall chimney.....	01 25.60	04 10.70	do.....	Do.
Center sec. 35, T. 22 N., R. 10 E.	19 12.20	01 52.20	do.....	Do.
Corner secs. 7 and 18, T. 19 N., R. 10 E., and secs. 12 and 13, T. 19 N., R. 9 E.	06 47.80	07 28.90	do.....	Do.
Corner secs. 14, 15, 22, and 23, T. 23 N., R. 10 E.	26 39.80	02 27.70	do.....	Do.
Land survey corner $\frac{1}{4}$ mile E. of corner of secs. 14, 15, 22, and 23, T. 23 N., R. 10 E.	26 39.90	02 10.60	do.....	Do.
	40°-41°	91°-92°		
Gillham.....	40 18 41.16	91 26 03.69	Miss. R. C.....	Rept. '84.
Hamilton.....	24 12.28	21 30.64	do.....	Do.
Church spire.....	23 34.60	20 52.85	do.....	Rept. '88.
Lima Lake.....	10 13.14	24 49.15	do.....	Rept. '84.
Rapids.....	25 16.66	21 49.71	do.....	Do.
Warsaw.....	22 01.44	25 40.96	do.....	Do.
Methodist Episcopal church spire.....	21 40.25	26 05.39	do.....	Rept. '88.
Presbyterian church spire.....	21 33.11	26 14.81	do.....	Do.
Worster.....	22 49.90	21 54.38	do.....	Rept. '84.
	39°-40°	87°-88°		
Belle Air.....	39 10 36.33	87 52 09.33	L. S.....	Final Rept.
Casey:				
Schoolhouse tower.....	18 03.80	59 02.10	do.....	Do.
Methodist church steeple.....	17 58.40	59 27.90	do.....	Do.
Kansas.....	30 51.85	51 48.11	do.....	Do.
Presbyterian church spire.....	33 22.70	56 11.60	do.....	Do.
Methodist church spire.....	33 08.60	56 22.20	do.....	Do.
Marshall Catholic church steeple.....	23 15.40	41 40.90	do.....	Do.
Martinsville.....	18 56.71	51 15.48	do.....	Do.
Palermo.....	52 33.82	52 03.20	do.....	Do.
Paris:				
Methodist church spire.....	36 45.60	41 41.60	do.....	Do.
Christian church steeple.....	36 36.20	41 38.90	do.....	Do.
Center of sec. 5, T. 16 N., R. 13 W.	52 21.60	52 16.20	do.....	Do.
Center of sec. 16, T. 10 N., R. 13 W.	19 03.40	51 10.60	do.....	Do.
Corner of secs. 4 and 5, T. 8 N., R. 13 W., and sec. 32, T. 9 N., R. 13 W.	10 35.20	52 32.60	do.....	Do.
Corner of secs. 5, 6, 7, and 8, T. 16 N., R. 13 W.	51 55.50	51 42.00	do.....	Do.
Southwest corner of sec. 4, T. 12 N., R. 13 W.	30 43.30	52 06.40	do.....	Do.
	39°-40°	88°-89°		
Casey.....	39 13 33.42	88 01 07.18	do.....	Do.
Hunt City.....	03 58.76	00 57.21	do.....	Do.

ILLINOIS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	39°-40°			88°-89°				
	°	'	"	°	'	"		
Lynn Grove.....	39	58	09.97	88	06	36.56	L. S.	Final Rept.
Mattoon.....		29	10.00		23	08.00	do	Do.
Oakland.....		42	31.90		02	35.30	do	Do.
Westfield.....		27	15.94		02	41.66	do	Do.
Methodist church, high steeple.....		27	21.40		00	01.80	do	Do.
Corners of T. 18 N., R. 10 E.; T. 17 N., R. 10 E.; T. 17 N., R. 9 E., and T. 18 N., R. 9 E.		58	03.40		07	24.00	do	Do.
Corner secs. 25, 26, 35, and 36, T. 12 N., R. 10 E.		26	58.70		02	43.00	do	Do.
Land survey mark $\frac{1}{2}$ mile west of cor- ner of secs. 25, 26, 35, and 36, T. 15 N., R. 10 E.		42	38.20		02	59.00	do	Do.
NE. corner sec. 18, T. 9 N., R. 11 E.		13	57.40		00	33.60	do	Do.
NE. corner sec. 7, T. 7 N., fractional R. 11 E.		04	08.20		01	25.80	do	Do.
NW. corner sec. 7, T. 7 N., R. 14 W.		04	08.30		01	25.90	do	Do.
	39°-40°			90°-91°				
Bellevue.....	39	21	55.20	90	47	39.66	Miss. R. C.	Rept. '84.
Hamburg.....		14	08.76		43	04.64	do	Do.
Long.....		28	49.67		55	27.58	do	Do.
Peets.....		06	18.90		39	52.86	do	Do.
Wilson.....		02	23.54		40	32.35	do	Do.
	39°-40°			91°-92°				
Gard.....	39	39	03.99	91	06	52.91	do	Do.
Marble Head.....		50	41.52		22	22.50	do	Do.
Inner base.....		29	04.94		01	19.09	do	Do.
Outer base.....		27	46.74		02	10.35	do	Do.
Quincy.....		56	31.00		24	51.18	do	Do.
Catholic church spire.....		55	03.63		24	17.01	do	Rept. '88.
Court-house.....		56	06.57		24	28.17	do	Do.
Rockport.....		32	48.61		00	58.40	do	Rept. '84.
	38°-39°			87°-88°				
Claremont.....	38	45	28.75	87	59	41.54	L. S.	Final Rept.
Oblong.....		59	54.58		52	30.54	do	Do.
SE. corner sec. 32, T. 7 N., R. 13 W.		59	51.60		52	17.60	do	Do.
	38°-39°			88°-89°				
Check base.....	38	48	20.73	88	01	58.29	do	
Denver.....		46	18.16		12	44.38	do	Do.
Dundas, tower Baptist church.....		50	06.10		05	03.60	do	Do.
East base.....		51	44.29		01	35.77	do	Do.
Mound.....		54	08.38		03	24.15	do	Do.
Olney:								
Tower schoolhouse, corner of Kitchell avenue and Church street.		43	42.00		05	12.60	do	Do.
Dome of court-house.....		43	50.60		05	08.70	do	Do.
Spire Immanuel's kirche.....		43	42.80		04	53.50	do	Do.
Onion Hill.....		48	57.72		10	27.97	do	Do.
Parkersburg.....		34	51.73		01	49.66	do	Do.
St. Marie, Catholic church.....		55	56.70		01	30.90	do	Do.
West base.....		51	38.76		06	09.04	do	Do.
Corner secs. 15, 16, 21, 22, T. 4 N., R. 9 E.		46	28.70		12	22.10	do	Do.
Corner secs. 19, 30, T. 2 N., R. 11 E., and secs. 24, 25, T. 2 N., R. 10 E.		35	07.20		02	18.60	do	Do.
NW. corner sec. 29, T. 4 N., R. 14 W.		45	42.50		00	11.90	do	Do.
German Reformed church, in sec. 6, T. 4 N., R. 11 E.		48	21.10		01	59.00	do	Do.
SW. corner NW. $\frac{1}{4}$ sec. 6, T. 4 N., R. 11 E.		48	46.80		02	18.90	do	Do.
NE. corner sec. 2, T. 4 N., R. 9 E.		49	03.50		10	08.40	do	Do.
NE. corner sec. 23, T. 5 N., R. 10 E.		51	50.80		03	25.50	do	Do.
NE. corner sec. 21, T. 5 N., R. 10 E.		51	47.90		05	41.20	do	Do.
NW. corner sec. 19, T. 5 N., R. 11 E.		51	51.90		02	18.40	do	Do.
Corner secs. 1, 2, 11, 12, T. 5 N., R. 10 E.		53	37.10		03	25.20	do	Do.
	38°-39°			89°-90°				
Reagan.....	38	01	29.48	89	59	08.01	do	Do.
	38°-39°			90°-91°				
Alton.....	38	53	30.96	90	11	35.62	Miss. R. C.	Rept. '84.
Catholic church.....		53	25.88		10	39.34	do	Rept. '88.
Schoolhouse, No. 5.....		53	31.77		10	12.27	do	Do.
Bocan.....		22	13.48		15	38.69	do	Rept. '84.
Brewerville.....		03	35.35		03	23.89	do	Do.
Cahill.....		59	24.38		40	20.75	do	Do.
Calhoun.....		55	26.78		34	35.83	do	Do.
Clark Mound.....		34	45.75		04	13.97	do	Do.
County Line.....		06	42.21		07	21.36	do	Do.
Droege.....		58	44.77		37	23.26	do	Do.

ILLINOIS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	38°-39°			90°-91°				
	°	'	"	°	'	"		
Dryer	38	20	06.33	90	11	55.71	Miss. R. C	Rept. '84.
Eagle Nest		56	04.97		18	40.13	do	Do.
Elsah		57	20.64		22	10.12	do	Do.
Gesler		50	51.51		06	26.25	do	Do.
Glass Works		53	02.06		10	20.84	do	Do.
Gillan		49	36.43		06	32.02	do	Do.
Grafton		58	22.48		27	08.82	do	Do.
Gummershimer		25	43.98		13	42.67	do	Do.
Hop Hollow		54	41.55		13	13.21	do	Do.
Hull		55	11.39		14	09.35	do	Do.
Keel		56	58.38		39	04.41	do	Do.
Kidd		10	22.49		12	58.13	do	Do.
Moore		48	08.12		07	05.82	do	Do.
Point Landing		54	43.53		31	44.55	do	Do.
Pettingill		46	16.76		08	50.56	do	Do.
Reihl		56	12.34		16	40.01	do	Do.
Ringing		51	32.91		07	48.91	do	Do.
Rivermouth		58	21.92		29	41.17	do	Do.
Russell		52	31.18		08	41.63	do	Do.
Salt Bluff		18	35.65		18	05.65	do	Do.
Sawmill		53	55.24		12	10.29	do	Do.
Soechtig		43	03.85		08	50.74	do	Do.
Starr		56	29.12		20	06.18	do	Do.
Sugarloaf		42	05.33		00	28.91	do	Do.
Thompson		58	43.32		32	28.42	do	Do.
Weisenborn		14	24.24		16	26.40	do	Do.
	37°-38°			89°-90°				
Atherton	37	07	23.82	89	22	43.05	do	Do.
Big Muddy		34	32.97		26	08.67	do	Do.
Bluff Lake		25	17.94		20	42.20	do	Do.
Burnham		08	31.43		24	32.43	do	Do.
Chester		54	09.65		48	43.55	do	Do.
Chester, church spire		54	55.36		49	21.22	do	Rept. '88.
Clear Creek		19	56.75		22	44.84	do	Rept. '84.
Day		14	00.04		27	14.93	do	Do.
Dickey		04	08.17		14	43.21	do	Do.
Fountain Bluff		41	36.77		30	00.16	do	Do.
Goose Island		05	35.96		22	58.78	do	Do.
Kaskaskia		57	41.83		55	07.40	do	Rept. '88.
Lassar		11	05.83		26	16.30	do	Rept. '84.
Manskeer		51	54.74		44	40.35	do	Do.
Murray		04	59.32		15	55.00	do	Do.
Nimbus		03	09.04		13	02.69	do	Do.
North base		02	21.94		11	31.84	do	Do.
O'Harrah		49	21.42		38	41.57	do	Do.
Powers Island		07	26.46		24	39.71	do	Do.
Promised Land		05	10.41		20	54.05	do	Do.
Rich		30	37.42		25	58.33	do	Do.
Santa Fe		10	05.16		25	28.60	do	Do.
Scudder		04	25.09		18	35.23	do	Do.
Sexton		15	05.07		26	42.99	do	Do.
South base		01	28.97		11	23.19	do	Do.
Spiese Mill		05	29.90		17	59.58	do	Do.
Swallow Rock		41	31.23		24	19.67	do	Do.
Thebes		12	30.91		27	15.55	do	Do.
Worthen		46	13.45		28	24.07	do	Do.
	36°-37°			89°-90°				
Cairo	36	59	47.99	89	09	31.20	L. S	Final Rept.

MICHIGAN.

	48°-49°			88°-89°				
	°	'	"	°	'	"		
Isle Royale	48	07	43.58	88	33	37.91	L. S	Final Rept.
Light-house		05	23.60		34	45.60	do	Do.
	47°-48°			87°-88°				
Stannard Rock, day beacon	47	10	37.70	87	13	23.10	do	Do.
Vulcan		26	46.65		47	38.17	do	Do.
	47°-48°			88°-89°				
Franklin shaft house	47	08	33.40	88	34	10.20	do	Do.
Traverse Point		08	42.06		13	59.86	do	Do.
Wheat Kate		04	20.27		39	45.21	do	Do.
	46°-47°			85°-86°				
Biddle Point	46	04	32.01	85	22	41.20	do	Do.
Manitou Payment		01	47.76		05	15.61	do	Do.

MICHIGAN—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	46°-47°	86°-87°		
	° ' "	° ' "		
Divide	46 21 41.12	86 39 37.71	L. S.	Final Rept.
Grand Island	31 43.34	41 35.49	do	Do.
Manistique	08 31.57	35 55.05	do	Do.
Mud Lake	19 14.00	48 24.45	do	Do.
Shelter Bay	28 17.93	59 16.95	do	Do.
Sturgeon	02 26.07	41 10.95	do	Do.
NW. corner of NE. $\frac{1}{4}$ sec. 16, T. 42 N., R. 19 W.	02 31.40	41 17.40	do	Do.
NE. corner sec. 27, T. 46 N., R. 19 W.	21 44.00	39 27.70	do	Do.
SE. corner sec. 4, T. 45 N., R. 20 W.	19 03.50	48 13.90	do	Do.
	46°-47°	87°-88°		
Baldwin	46 32 57.85	87 35 05.25	G. S.	Bull. 122
Carp	30 06.70	25 05.84	do	Do.
Dexter	30 02.57	47 33.91	do	Do.
F	28 18.28	36 55.47	do	Do.
Granite Island	43 15.47	24 41.29	L. S.	Final Rept.
Light-house	43 15.00	24 43.70	do	Do.
Huron Island light-house	57 47.70	59 56.40	do	Do.
Huron Mountains	52 42.30	55 17.59	do	Do.
Ives Hill	49 26.19	50 05.66	do	Do.
Marquette:				
Light-house	32 47.90	22 34.70	do	Do.
Methodist church spire	32 43.40	23 31.70	do	Do.
City hall dome	32 30.00	23 47.60	do	Do.
Mount Mesnard	30 48.34	23 59.23	do	Do.
Morgan	31 48.26	30 55.32	G. S.	Bull. 122.
Saginaw	27 41.10	43 00.52	do	Do.
Triloba	36 17.94	29 21.83	L. S.	Final Rept.
	46°-47°	88°-89°		
Crebassa	46 59 00.52	88 24 18.17	do	Do.
Middle	55 55.09	14 22.75	do	Do.
North base	56 48.01	26 59.46	do	Do.
Portage River light-house	58 41.10	24 50.70	do	Do.
Quaquaming	52 20.23	22 21.79	do	Do.
South base	52 17.76	29 16.75	do	Do.
	46°-47°	89°-90°		
Ontonagon County light-house	46 52 27.60	89 19 33.40	do	Do.
Porcupine Mountain	47 01.05	43 50.84	do	Do.
	45°-46°	84°-85°		
Beaver Tail	45 57 56.72	84 10 15.24	do	Do.
Bois Blanc Island	46 19.12	21 21.47	do	Do.
East base	45 22.14	42 02.99	do	Do.
Gros Cap	52 57.81	50 06.98	do	Do.
Mackinac Island	51 28.73	36 58.03	do	Do.
Mast	34 28.44	08 25.89	do	Do.
Pointe aux Chênes	55 39.82	54 48.49	do	Do.
Pointe Fuyard	55 58.07	22 48.77	do	Do.
Pointe St. Martin	58 10.21	31 55.29	do	Do.
Rabbit Back	55 17.84	43 18.97	do	Do.
Round Island astronomical station	50 06.81	36 44.60	do	Do.
St. Ignace	51 09.12	43 36.09	do	Do.
Spectacle Reef	46 05.02	08 10.73	do	Do.
West base	47 13.80	46 22.40	do	Do.
	45°-46°	85°-86°		
Beaver Island	45 36 25.56	85 29 49.27	do	Do.
Cathead	10 58.09	37 05.65	do	Do.
Garden Island	49 19.46	31 13.82	do	Do.
Gull Island	42 09.24	50 00.32	do	Do.
Hat Island	49 01.87	17 57.18	do	Do.
High Island	43 54.35	41 01.50	do	Do.
Middle Village	34 42.39	06 13.43	do	Do.
North Fox	28 09.94	46 26.25	do	Do.
North Manitou	03 51.52	59 44.32	do	Do.
Pine River	19 55.73	14 50.43	do	Do.
Point Patterson	58 04.29	39 15.18	do	Do.
Seul Choix	55 14.69	54 40.40	do	Do.
Scott Point	57 34.63	41 44.46	do	Do.
South Fox	24 58.05	51 37.49	do	Do.
	45°-46°	86°-87°		
Boyer Bluff	45 25 12.81	86 56 11.49	do	Do.
Burnt Bluff	41 09.73	42 39.83	do	Do.
Fishdam	57 37.33	29 34.19	do	Do.
Northwest Manitou	09 23.00	02 46.52	do	Do.
Peninsula Point light-house	40 04.60	58 02.40	do	Do.
Pine Hill	51 36.96	53 55.48	do	Do.
Rock Island	24 53.11	49 00.00	do	Do.
South Manitou	00 35.24	09 01.74	do	Do.

MICHIGAN—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	45°-46° ° ' "	87°-88° ° ' "		
Bark River.....	45 34 30.78	87 14 25.94	L. S.....	Final Rept.
Cedar River.....	25 48.62	19 35.05	do.....	Do.
Door Bluff.....	17 46.97	03 54.60	do.....	Do.
Ford River.....	41 05.34	06 01.35	do.....	Do.
Do.....	41 12.16	06 09.40	do.....	Do.
Menomonee, new primary triangulation station.	05 12.78	35 27.75	do.....	Do.
Rochereau.....	17 41.23	26 12.51	do.....	Do.
SE. corner sec. 12, T. 38 N., R. 23 W....	41 12.90	06 03.40	do.....	Do.
	44°-45°	82°-83°		
Pointe aux Barques.....	44 04 05.58	82 57 32.52	do.....	Do.
	44°-45°	83°-84°		
Big Charity.....	44 02 17.46	83 26 27.97	do.....	Do.
Charity light-house.....	02 16.30	26 27.70	do.....	Do.
Gravelly Point.....	02 58.79	34 44.06	do.....	Do.
Little Charity.....	00 08.81	28 02.72	do.....	Do.
Mason Creek.....	11 39.56	33 20.34	do.....	Do.
Pointe au Sable.....	20 17.79	20 03.64	do.....	Do.
Tawas light-house.....	15 35.40	26 37.70	do.....	Do.
Tawas Point.....	15 38.14	26 29.19	do.....	Do.
Whitestone.....	06 24.72	33 54.33	do.....	Do.
	44°-45°	85°-86°		
Pyramid Point.....	44 58 04.40	85 55 28.16	do.....	Do.
	44°-45°	86°-87°		
Pointe aux Becs Scies.....	44 41 48.58	86 14 59.36	do.....	Do.
Sleeping Bear.....	52 22.69	04 08.05	do.....	Do.
	43°-44°	83°-84°		
East base.....	43 54 55.71	83 19 10.78	do.....	Do.
Fish Point.....	42 49.02	31 39.49	do.....	Do.
Flint:				
Intersection of Keasley and East streets.	01 11.71	41 06.45	do.....	Do.
Intersection of Keasley and Saginaw streets.	01 01.20	41 29.30	do.....	Do.
Lapeer:				
Intersection of Calhoun and Liberty streets.	03 08.60	18 53.50	do.....	Do.
Intersection of Calhoun and Franklin streets.	03 07.30	18 53.40	do.....	Do.
Nyaquonk.....	47 24.74	55 32.76	do.....	Do.
Oak Point.....	58 29.77	15 40.03	do.....	Do.
Observatory.....	54 39.79	22 51.00	do.....	Do.
Pine River.....	58 42.70	51 13.62	do.....	Do.
Pointe aux Gres.....	59 27.88	40 38.96	do.....	Do.
Quannakissee.....	37 03.81	44 10.09	do.....	Do.
Saginaw River light-house.....	38 37.80	51 17.50	do.....	Do.
Saginaw:				
Court-house, east corner.....	25 05.70	57 50.30	do.....	Do.
Jail, south corner.....	25 08.40	57 48.40	do.....	Do.
Intersection of Adams and Washington streets.	25 02.00	57 50.20	do.....	Do.
Sebonin.....	51 32.16	26 57.65	do.....	Do.
West base.....	54 39.15	23 56.71	do.....	Do.
Wild fowl.....	51 24.53	21 28.39	do.....	Do.
NE. corner sec. 26, T. 12 N., R. 4 E....	25 27.10	57 25.30	do.....	Do.
SW. corner of SW. ¼ of sec. 32, T. 8 N., R. 10 E.	03 26.30	18 55.60	do.....	Do.
St. Johns:	43°-44°	84°-85°		
Intersection of axes of State and Ottawa streets.	43 00 02.60	84 33 47.00	do.....	Do.
Corner stone at northwest corner of court-house.	00 00.10	33 37.20	do.....	Do.
Intersection of axes of Clinton avenue and State street.	00 02.39	33 36.60	do.....	Do.
St. Louis, intersection of Washington and Mill streets.	24 33.00	36 24.70	do.....	Do.
NW. corner sec. 16, T. 7 N., R. 2 W....	00 02.80	33 51.10	do.....	Do.
SW. corner sec. 19, T. 12 N., R. 2 W....	24 33.00	36 19.00	do.....	Do.
Stanton:	43°-44°	85°-86°		
County record office, northwest corner.	43 17 29.00	85 04 58.40	do.....	Do.
Intersection of Main and Cambridge streets.	17 30.70	04 52.50	do.....	Do.
SW. corner sec. 31, T. 11 N., R. 6 W....	17 30.70	05 03.20	do.....	Do.
SW. corner sec. 18, T. 12 N., R. 12 W....	25 26.10	48 10.40	do.....	Do.
	42°-43°	83°-84°		
Barker.....	42 07 39.50	83 08 26.30	do.....	Do.
Biddle.....	08 02.90	08 17.80	do.....	Do.

MICHIGAN—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43° ° ' "	83°-84° ° ' "		
Brodhead	42 09 30.50	83 08 15.90	L. S.	Final Rept.
Detroit:				
Astronomical post (east pier) in lake observatory.	20 00.80	03 07.40	do	Do.
Intersection of axes of Washington and Grand River avenues.	20 01.40	03 04.50	do	Do.
Spire St. Paul's Episcopal church, on northeast corner of Congress and Shelby streets.	19 45.90	02 53.60	do	Do.
Tower of fire-engine house on Russell street.	20 41.00	02 21.50	do	Do.
East pier lake survey observatory.	19 58.65	03 03.60	do	Do.
Ecorse	15 21.40	08 09.50	do	Do.
Field	17 34.20	06 23.10	do	Do.
Howell:				
Astronomical post	36 00.24	55 44.25	Engr. Corps ..	Rept. '76.
Intersection Higgins and Monroe streets.	36 11.18	55 50.85	L. S.	Final Rept.
Intersection of axes of Grand River and Higgins streets.	36 23.20	55 42.60	do	Do.
Southwest corner of court-house.	36 24.50	55 41.40	do	Do.
North Wyandotte	12 49.20	08 48.50	do	Do.
Pointe Monillée	00 49.60	10 53.70	do	Do.
Pontiac:				
Methodist Episcopal church spire.	38 03.20	17 20.50	do	Do.
Intersection of axes of Saginaw and Church streets.	38 06.70	17 22.60	do	Do.
Court-house cupola	38 22.00	17 30.00	do	Do.
SE. corner sec. 29, T. 3 N., R. 10 E.	38 06.95	17 15.60	do	Do.
River Rouge	16 15.40	07 34.90	do	Do.
Tecumseh Presbyterian church	00 15.00	56 54.60	do	Do.
Sugar Island	05 25.40	08 35.40	do	Do.
NW. corner sec. 1, T. 2 N., R. 4 E.	35 59.60	56 01.60	do	Do.
SE. corner, sec. 29, T. 3 N., R. 10 E.	38 07.00	17 15.50	do	Do.
	42°-43° ° ' "	84°-85° ° ' "		
Bunday	42 03 16.04	84 27 42.10	do	Do.
Charlotte:				
Intersection of axes of Oliver and Stoddard streets.	33 58.96	50 01.20	do	Do.
Jail, northwest corner	33 52.40	50 13.90	do	Do.
Corunna:				
Intersection of axes of McArthur street and Shiawassee avenue.	58 52.00	07 02.90	do	Do.
Intersection of axes of Shiawassee avenue and Flint road.	58 37.92	07 02.85	do	Do.
Court-house, southwest corner ..	58 54.30	07 00.80	do	Do.
Northeast corner schoolhouse on corner of State street and Shiawassee avenue.	58 47.50	07 05.00	do	Do.
Jackson:				
Cornwell & Emerson's chemical works, brick chimney.	15 45.50	24 23.90	do	Do.
Hibbard House, northeast corner.	14 48.90	24 13.70	do	Do.
First Methodist Episcopal church spire.	14 50.00	24 39.60	do	Do.
Intersection of axes of Main and Mechanics streets.	14 49.40	24 19.20	do	Do.
Michigan State Prison, main tower.	14 34.70	24 36.60	do	Do.
Intersection of axes of Main and Jackson streets.	14 49.40	24 36.00	do	Do.
Lansing:				
Dome of capitol	43 56.10	33 23.20	do	Do.
Intersection of Washtenaw and Washington avenues.	43 47.60	33 11.20	do	Do.
Intersection of Michigan and Capitol avenues.	43 55.79	33 16.95	do	Do.
Marshall.				
Intersection of Kalamazoo avenue and Mansion street.	16 24.70	57 49.20	do	Do.
Court-house, northwest corner ..	16 16.70	57 47.00	do	Do.
NE. corner sec. 16, T. 4 N., R. 2 W.	44 21.90	32 37.40	do	Do.
NE. corner sec. 13, T. 2 N., R. 5 W.	34 04.30	50 10.10	do	Do.
NW. corner sec. 2, T. 3 S., R. 1 W.	14 49.30	24 12.40	do	Do.
NW. corner sec. 25, T. 2 S., R. 6 W.	16 27.60	57 49.20	do	Do.
SE. corner sec. 8, T. 5 S., R. 1 W.	03 55.00	29 00.40	do	Do.
SW. corner sec. 28, T. 7 N., R. 3 E.	58 11.20	07 40.30	do	Do.
Allegan:	42°-43° ° ' "	85°-86° ° ' "		
County record building, northwest corner.	42 31 44.70	85 51 08.50	do	Do.

MICHIGAN—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			85°-86°				
	°	'	"	°	'	"		
Allegan—Continued.								
Intersection of axes of Walnut and Trowbridge streets.	42	31	45.60	85	51	09.70	L. S.	Final Rept.
Northwest corner county building, public square.	31	44.74		51	08.55		do	Do.
Grand Rapids:								
SW. corner of NW. $\frac{1}{4}$ of sec. 30, T. 7 N., R. 11 W., at intersection of Fulton and Division streets.	57	47.00		40	06.20		do	Do.
Intersection of axes of Fulton street and Jefferson avenue.	57	47.10		39	52.90		do	Do.
Hastings:								
Intersection of Church and State streets.	38	54.13		17	17.55		do	Do.
Court-house, southwest corner	38	51.60		17	20.40		do	Do.
Intersection of axes of Broadway and Court streets.	38	50.70		17	23.00		do	Do.
Ionia:								
Intersection of axes of Main and Kidd streets.	58	51.90		03	47.00		do	Do.
Intersection of axes of Main and First streets.	58	51.39		03	53.25		do	Do.
Southeast corner of corner stone of projected soldiers' monument.	58	52.90		03	49.70		do	Do.
Kalamazoo:								
Intersection of axes of South and Church streets.	17	24.60		35	07.30		do	Do.
Intersection of axes of South and Park streets.	17	24.46		35	11.70		do	Do.
Jail, southwest corner	17	28.40		35	05.70		do	Do.
Paw Paw, intersection of axes of Main and Van Buren streets.	13	01.70		53	03.40		do	Do.
NW. corner sec. 17, T. 3 N., R. 8 W.	39	11.60		17	23.30		do	Do.
NW. corner sec. 28, T. 2 N., R. 13 W.	32	10.50		51	32.10		do	Do.
SE. corner of NE. $\frac{1}{4}$ of sec. 19, T. 7 N., R. 6 W.	58	42.10		03	18.60		do	Do.
SW. corner sec. 7, T. 3 N., R. 13 W.	12	55.00		52	40.40		do	Do.
SW. corner sec. 15, T. 2 S., R. 11 W.	17	21.00		35	20.10		do	Do.
	42°-43°			86°-87°				
St. Joseph, Congregational church spire.	42	06	19.00	86	29	00.10	do	Do.
SW. corner sec. 36, T. 1 N., R. 17 W.	25	08.80		15	56.30		do	Do.
	41°-42°			83°-84°				
Bedford	41	49	11.15	83	37	06.14	do	Do.
Blissfield		51	08.39		48	27.86	do	Do.
Dundee		55	28.08		40	13.93	do	Do.
Middle Sister		50	53.03		00	07.80	do	Do.
Monroe		55	04.51		28	16.17	do	Do.
Court-house steeple		54	48.65		23	46.35	do	Do.
Methodist Episcopal church spire		54	52.40		23	56.60	do	Do.
Presbyterian church spire		54	53.40		23	51.40	do	Do.
German Lutheran church spire		54	43.40		23	49.10	do	Do.
Light-house		53	27.70		19	53.20	do	Do.
Raisin		57	11.50		55	30.14	do	Do.
Stony Point		55	53.86		15	51.33	do	Do.
Corner of secs. 14, 15, 22, and 23, T. 6 S., R. 4 E.		56	57.10		55	34.30	do	Do.
Corner of secs. 22, 23, 26, and 27, T. 7 S., R. 5 E.		50	57.00		48	26.90	do	Do.
Corner of secs. 25, 26, 35, and 36, T. 6 S., R. 6 E.		55	28.20		40	18.70	do	Do.
NE. corner sec. 5, T. 8 S., R. 7 E.		49	19.80		36	32.40	do	Do.
	41°-42°			84°-85°				
Adrian, flagstaff on engine house	41	53	45.40	84	01	36.80	do	Do.
Fairfield		48	56.12		02	37.00	do	Do.
Hillsdale		55	14.25		39	01.08	do	Do.
Court-house dome		55	15.40		37	54.60	do	Do.
College clock tower		55	57.00		38	02.00	do	Do.
Hudson Congregational church spire		51	12.60		21	25.80	do	Do.
Pittsford		49	33.25		29	00.51	do	Do.
Prattville church		46	50.10		24	00.10	do	Do.
Quincy		57	40.01		55	20.05	do	Do.
Reading		50	06.06		44	31.56	do	Do.
Schoolhouse cupola		50	16.20		44	45.40	do	Do.
Colby Wringer Co. factory, southeast corner.		50	07.10		44	33.20	do	Do.
First Baptist church spire		50	18.50		44	46.80	do	Do.
Wheatland		55	06.32		27	19.48	do	Do.
Woodstock		59	12.55		15	35.76	do	Do.

MICHIGAN—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	41°-42° ° ' "	84°-85° ° ' "		
Corner of secs. 19, 20, 29, and 30, T. 6 S., R. 1 E.	41 55 38.60	84 27 34.20	L. S.	Final Rept.
Corner of secs. 22, 23, 26, and 27, T. 7 S., R. 4 W.	50 22.70	44 53.20	do	Do.
NE. corner sec. 3, T. 8 S., R. 3 E.	49 00.20	02 30.10	do	Do.
NE. corner sec. 4, T. 6 S., R. 1 E.	59 11.90	14 46.60	do	Do.
NE. corner sec. 26, T. 7 S., R. 4 W.	50 22.40	43 42.60	do	Do.
NW. corner sec. 27, T. 6 S., R. 3 W.	55 38.10	39 05.00	do	Do.
SE. corner sec. 36, T. 7 S., R. 2 W.	48 41.00	28 34.80	do	Do.
SW. corner of SW. $\frac{1}{4}$ of sec. 7, T. 6 S., R. 5 W.	57 22.70	55 55.70	do	Do.
SW. corner of NW. $\frac{1}{4}$ of sec. 27, T. 6 S., R. 3 W.	55 11.90	39 05.10	do	Do.
SW. corner of NW. $\frac{1}{4}$ of sec. 29, T. 6 S., R. 1 W.	55 12.70	27 34.20	do	Do.
	41°-42° ° ' "	85°-86° ° ' "		
Bronson	41 51 22.46	85 14 38.98	do	Do.
Calvin	50 10.38	55 27.18	do	Do.
Constantine schoolhouse, north cupola	50 07.10	40 01.10	do	Do.
Porter	49 22.48	46 00.10	do	Do.
Sherman	50 48.58	27 12.45	do	Do.
Sturgis:				
Presbyterian church spire	48 03.50	25 08.50	do	Do.
Methodist Episcopal church spire	48 01.20	25 08.80	do	Do.
Schoolhouse	48 05.60	25 11.20	do	Do.
Three Rivers:				
Tall steeple	56 54.20	38 04.50	do	Do.
Church	56 59.00	38 06.30	do	Do.
White Pigeon:				
First Baptist church	47 47.40	38 35.40	do	Do.
Woolen mill	47 41.90	38 28.90	do	Do.
SW. corner of SW. $\frac{1}{4}$ of sec. 16, T. 7 S., R. 8 W.	51 16.10	14 36.00	do	Do.
SW. corner of SE. $\frac{1}{4}$ of sec. 22, T. 7 S., R. 10 W.	50 21.40	27 28.80	do	Do.
SW. corner of NW. $\frac{1}{4}$ of sec. 27, T. 7 S., R. 14 W.	49 57.70	56 07.30	do	Do.
SW. corner of NW. $\frac{1}{4}$ of sec. 36, T. 7 S., R. 13 W.	48 59.40	46 47.40	do	Do.
	41°-42° ° ' "	86°-87° ° ' "		
Bald Tom	41 54 19.34	86 35 59.45	do	Do.
Bertrand	46 44.96	22 40.33	do	Do.
Milton	48 09.36	10 29.74	do	Do.
Corner secs. 4, 5, 8, and 9, T. 8 S., R. 16 W.	47 49.80	11 10.30	do	Do.
Corner secs. 14, 15, 22, and 23, T. 8 S., R. 18 W.	46 34.90	22 39.70	do	Do.
SE. corner sec. 35, T. 6 S., R. 20 W.	53 58.60	35 23.90	do	Do.

WISCONSIN.

	47°-48° ° ' "	90°-91° ° ' "		
Outer Island	47 04 17.09	90 26 27.25	L. S.	Final Rept.
Bayfield County:	46°-47° ° ' "	90°-91° ° ' "		
Light-house on Raspberry Island	46 58 12.80	90 48 16.70	do	Do.
Light-house on Michigan Island	52 16.30	29 48.80	do	Do.
Detour	56 36.68	58 09.32	do	Do.
	46°-47° ° ' "	91°-92° ° ' "		
Aminicon	46 41 32.14	91 51 43.59	do	Do.
Brulé	45 17.89	35 18.79	do	Do.
Clay Banks	49 05.61	18 40.63	do	Do.
	46°-47° ° ' "	92°-93° ° ' "		
South base	46 42 49.44	92 01 55.13	do	Do.
	45°-46° ° ' "	86°-87° ° ' "		
Door County, light-house on Rock Island (Pottawatomie).	45 25 39.50	86 49 41.60	do	Do.
Boyer Bluff	25 12.74	56 11.48	do	Do.
	45°-46° ° ' "	87°-88° ° ' "		
Door Bluff	45 17 46.97	87 03 54.60	do	Do.
Door County, light-house on Eagle Bluff.	10 07.50	14 12.30	do	Do.
Do	12 08.20	21 53.60	do	Do.
Eagle Bluff	10 06.62	14 13.66	do	Do.
Menomonee	05 12.76	35 34.60	do	Do.

WISCONSIN—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	45°-46° ° ' ''	87°-88° ° ' ''		
Oconto County :				
NE. corner sec. 3, T. 30 N., R. 23 E.	45 06 24.20	87 39 42.90	L. S.	Final Rept.
Light-house on Green Island	03 23.20	29 34.60	do	Do.
St. Croix County :	45°-46°	92°-93°		
SE. corner sec. 34, T. 31 N., R. 19 W.	45 07 21.80	92 41 24.60	do	Do.
SW. corner sec. 33, T. 31 N., R. 19 W.	07 22.10	43 52.10	do	Do.
Brown County, NW. corner sec. 25, T. 24 N., R. 21 E.	44°-45° 44 31 53.70	87°-88° 87 54 25.20	do	Do.
Bruce	31 39.37	53 58.14	do	Do.
Debroux	50 19.43	36 28.84	do	Do.
Gales	51 14.48	51 26.86	do	Do.
Little Tail	41 14.76	59 23.07	do	Do.
Long Tail Point	35 49.10	58 59.20	do	Do.
Peshtigo	59 06.73	37 43.23	do	Do.
Red Banks	36 40.26	51 54.19	do	Do.
Red River	45 40.00	41 07.07	do	Do.
South Egg	59 20.75	21 05.79	do	Do.
Appleton, St. Lawrence University, center of dome.	44°-45° 44 15 39.20	88°-89° 88 23 58.80	do	Do.
Calumet	10 12.64	16 45.78	do	Do.
County, NW. corner sec. 31, T. 20 N., R. 19 E.	10 12.80	17 02.20	do	Do.
Clayton	12 04.07	32 41.11	do	Do.
East Depere	24 19.52	00 27.38	do	Do.
Fort Howard	30 30.28	02 34.05	do	Do.
Freedom	20 06.61	22 00.92	do	Do.
Green Bay, court-house dome	30 50.90	00 48.00	do	Do.
Oneida	31 36.53	10 09.68	do	Do.
Outagamie County, SE. corner sec. 35, T. 21 N., R. 17 E.	14 38.70	23 43.70	do	Do.
Oshkosh	01 13.64	32 28.14	do	Do.
Stockbridge	06 16.17	19 26.12	do	Do.
West Depere	24 12.73	16 16.02	do	Do.
Winnebago County, SW. corner sec. 13, T. 20 N., R. 16 E.	11 58.90	32 39.30	do	Do.
Monroe County :	44°-45°	90°-91°		
NE. corner sec. 1, T. 18 N., R. 1 W.	44 04 26.60	90 25 56.70	do	Do.
SE. corner sec. 13, T. 18 N., R. 1 W.	01 49.60	25 56.00	do	Do.
Valley Junction, SW. corner sec. 31, T. 21 N., R. 3 E.	14 57.24	25 56.70	do	Do.
Milwaukee :	43°-44°	87°-88°		
Court-house, axis of figure of Justice.	43 02 31.80	87 54 18.40	do	Do.
Catholic church spire	02 30.50	54 15.00	do	Do.
Brown church	43°-44° 43 16 42.19	88°-89° 88 52 53.63	C. & G. S.	Bull. 122. Final Rept.
Canty	23 19.58	04 37.41	G. S.	
Delafield	01 56.97	23 34.00	L. S.	
Do	01 59.46	23 29.35	C. & G. S.	
Dodge County :				
SW. corner of SE. $\frac{1}{4}$ sec. 24, T. 12 N., R. 15 E.	28 24.50	44 01.90	L. S.	Do.
NW. corner of SW. $\frac{1}{4}$ sec. 3, T. 9 N., R. 16 E.	16 36.00	35 48.60	do	Do.
SW. corner sec. 3, T. 9 N., R. 16 E.	16 09.70	35 48.30	do	Do.
SE. corner sec. 33, T. 12 N., R. 16 E.	27 28.60	34 52.60	do	Do.
NW. corner sec. 3, T. 13 N., R. 16 E.	37 56.70	34 55.10	do	Do.
SE. corner of SW. $\frac{1}{4}$ sec. 33, T. 11 N., R. 17 E.	22 14.30	29 29.00	do	Do.
SE. corner sec. 32, T. 11 N., R. 17 E.	22 14.30	30 04.70	do	Do.
East base	42 39.67	28 42.05	do	Do.
Eldorado	52 20.81	34 54.97	do	Do.
Erin	14 39.00	19 39.88	G. S.	Bull. 122.
Do	14 41.49	19 35.18	C. & G. S.	
Fond du Lac County :				
Spire of Catholic church in Byron Township.	40 29.00	27 02.50	L. S.	Final Rept.
NE. corner sec. 10, T. 14 N., R. 16 E.	42 19.00	33 47.30	do	Do.
SW. corner sec. 10, T. 16 N., R. 16 E.	51 54.30	35 03.80	do	Do.
NW. corner SW. $\frac{1}{4}$ sec. 34, T. 14 N., R. 16 E.	38 22.50	34 54.90	do	Do.
SW. corner sec. 34, T. 14 N., R. 16 E.	37 56.60	34 54.30	do	Do.
NW. corner sec. 4, T. 14 N., R. 17 E.	43 08.60	28 56.10	do	Do.
SW. corner sec. 20, T. 16 N., R. 18 E.	50 01.70	22 55.40	do	Do.
Holl	20 41.62	15 51.27	G. S.	Bull. 122.
Horicon	28 11.07	34 54.84	L. S.	Final Rept.

WISCONSIN—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	43°-44°			88°-89°				
	°	'	"	°	'	"		
Jefferson :								
Catholic church	43	00	20.30	88	46	41.19	C. & G. S.	
Methodist Episcopal church		00	27.10		48	05.67	do	
Kewaskum		29	36.18		13	33.43	G. S.	Bull. 122.
Lebanon		16	37.61		35	29.84	C. & G. S.	
Do		16	35.13		35	34.51	L. S.	Final Rept.
Minnesota Junction		28	28.45		43	47.54	do	Do.
New Lisbon		08	16.85		11	57.32	do	Do.
Oakfield		38	20.04		34	36.51	do	Do.
Springvale		46	05.32		43	54.06	do	Do.
Taycheedah		50	06.63		22	19.17	do	Do.
Watertown, church		11	43.03		43	39.49	C. & G. S.	
Waupun		37	45.11		43	49.81	L. S.	Do.
West base		41	50.58		34	06.62	do	Do.
Woodland		22	37.90		28	51.60	G. S.	Bull. 122.
Do		22	14.71		29	50.48	L. S.	Final Rept.
	43°-44°			89°-90°				
Arena, church belfry	43	09	53.11	89	54	46.38	C. & G. S.	
Arlington		19	42.84		18	14.00	do	
Blue Mounds		01	43.57		51	04.60	do	
Burke		07	01.65		16	48.41	do	
Courtland		30	04.98		06	37.52	do	
Deerfield, church		02	29.06		06	21.96	do	
Devils Lake		24	03.37		43	41.59	do	
Fitz Simmons		25	42.56		39	10.30	do	
Gibraltar		20	37.75		35	56.06	do	
Insane asylum		08	00.13		23	48.29	do	
Liberty Mound		01	00.30		09	40.75	do	
McFarland, church		00	57.78		17	05.04	do	
Madison :								
Astronomic station (1873), stone		04	33.03		24	03.41	do	
Baptist church		04	26.44		23	01.13	do	
Capitol		04	31.42		22	58.22	do	
City Hall		04	34.43		23	04.24	do	
Episcopal church		04	28.73		23	03.96	do	
Congregational church		04	26.52		23	07.18	do	
Irish Catholic church		04	22.23		23	04.41	do	
Presbyterian church		04	40.23		23	08.53	do	
University		04	33.81		24	10.39	do	
Mazomanie church, white steeple		10	42.56		47	47.55	do	
Medina		07	36.96		02	11.84	do	
Norwegian church		00	23.86		41	24.11	do	
Observatory Hill		42	22.04		20	29.06	do	
Springfield		10	30.04		36	47.84	do	
St. Martin's church		10	55.68		35	21.23	do	
Stewart		12	01.90		56	37.26	do	
Sun Prairie, highest church spire		11	08.97		12	36.13	do	
Windsor		14	23.94		16	18.35	do	
	43°-44°			90°-91°				
Bear Bluff	43	13	04.04	90	08	35.23	do	
Big Hollow		12	45.42		05	43.04	do	
Brown church steeple		02	55.67		16	45.80	do	
Helena		09	03.44		00	30.78	do	
Railroad bridge, bolt		10	28.79		01	50.08	do	
Highland		06	06.55		21	51.28	do	
Catholic church		02	49.26		22	53.51	do	
Lone Rock :								
Church spire		11	02.75		11	57.53	do	
Bluff		09	54.20		13	00.66	do	
Meridian station, 2		07	57.51		25	43.07	do	
Pine Knobs		04	38.46		01	59.09	do	
Point Judas		13	07.82		13	53.99	do	
Quarry Bluff		12	23.38		03	26.63	do	
Spring Green :								
Methodist Episcopal church spire		10	43.38		04	05.38	do	
Base, east end		09	41.40		03	45.04	do	
Base, west end		10	46.50		06	52.10	do	
Wyoming		04	28.92		10	54.38	do	
	42°-43°			87°-88°				
Caledonia	42	45	32.89	87	56	48.43	L. S.	Final Rept.
Kenosha, Catholic church spire		35	32.90		49	17.70	do	Do.
Racine, Methodist Episcopal church		43	28.70		46	56.90	do	Do.
Somer		37	10.07		52	33.60	do	Do.
	42°-43°			88°-89°				
Bald Bluff	42	50	42.76	88	36	15.73	C. & G. S.	
Bristol		32	51.61		02	08.78	L. S.	Do.
Clinton :								
Norwegian Lutheran church		29	37.73		50	35.04	C. & G. S.	
Junction church		33	41.82		51	38.34	do	
Darien church		35	59.85		42	24.49	do	

WISCONSIN—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43° ° ' "	88°-89° ° ' "		
Dover	42 40 25.35	88 05 03.68	L. S.	Final Rept.
Geneva	37 07.79	32 08.96	C. & G. S.	
Harmony	42 34.43	55 16.83	do	Do.
New Berlin	58 17.60	11 01.80	L. S.	
Oakland	59 14.40	53 45.16	C. & G. S.	Do.
Shopiere church	34 16.69	56 12.62	do	
Waterford	47 34.91	13 50.73	L. S.	Do.
Whitewater	50 13.32	44 33.45	C. & G. S.	
Congregational church	50 05.05	44 05.54	do	Do.
Waukesha County, NW. corner sec. 19, T. 6 N., R. 20 E.	58 25.80	11 16.30	L. S.	
Beloit:	42°-43°	89°-90°		
City school	42 30 06.17	89 01 30.66	C. & G. S.	Do.
College, main building	30 13.36	01 46.84	do	
Baptist church	30 01.65	01 53.45	do	Do.
Congregational church	30 08.13	01 35.79	do	
Memorial Hall	30 08.66	01 44.94	do	Do.
Presbyterian church	29 57.06	01 55.71	do	
Centennial, Methodist Episcopal church.	42 19.25	59 04.74	do	Do.
Church of the Disciples	42 33.71	10 49.25	do	
Edgerton church	50 13.44	04 13.89	do	Do.
Evansville, seminary	46 39.22	18 03.02	do	
Fayette	43 16.80	59 38.09	do	Do.
Fitchburg	58 45.77	26 07.65	do	
Janesville	42 47.86	03 39.79	do	Do.
Blind Institute	39 55.91	02 20.37	do	
City school	40 57.56	00 53.22	do	Do.
Magnolia	42 29.04	17 44.87	do	
Monroe:				
Methodist Episcopal church	36 08.00	38 29.52	do	Do.
Congregational church	36 15.01	38 09.72	do	
Universalist church	36 13.82	38 16.81	do	Do.
Mount Pleasant	41 30.25	29 45.78	do	
Newark	29 55.62	12 36.97	do	Do.
Baptist church	34 14.11	10 00.58	do	
Lutheran church	34 42.32	12 22.97	do	Do.
Norwegian Lutheran church	45 35.42	54 17.00	do	
Pleasant Springs	57 15.42	08 08.93	do	Do.
Plymouth	35 24.46	10 04.29	do	
Rock church	57 14.36	02 48.01	do	Do.
Union	47 28.75	12 21.88	do	
Wohlford	32 51.49	05 57.45	do	Do.
	42°-43°	90°-91°		
Azimuth mark	42 30 03.19	90 13 37.24	do	Do.
Beetown	50 02.93	46 26.62	do	
Dodgeville, church steeple	57 43.77	07 45.27	do	Do.
Do	57 45.60	07 51.44	do	
Dutch Hollow church	41 29.60	40 49.75	do	Do.
Fennimore	58 28.53	40 45.85	do	
Church	58 55.87	39 06.79	do	Do.
Gratiot Grove	32 34.57	13 37.40	do	
Harker	59 03.23	10 29.78	do	Do.
Meridian Station No. 1	45 45.28	25 30.22	do	
Mineral Point, Catholic church	51 34.35	11 06.10	do	Do.
Mount Ida	57 20.95	45 29.70	do	
Platte Mound	45 55.05	24 16.53	do	Do.
Plattsville, Normal School	44 09.47	28 48.52	do	
Shullsburg, Catholic church	34 32.96	13 45.99	do	Do.
Sinsinawa Mound	31 32.08	32 32.13	do	
Waldwick	52 29.14	05 51.35	do	Do.
Windmill	58 54.14	20 01.96	do	
Wingville church	58 25.01	25 53.54	do	Do.
SW. corner sec. 31, T. 1 N., R. 1 W., Grant County.	30 26.40	26 44.20	L. S.	

MINNESOTA.

	47°-48° ° ' "	89°-90° ° ' "		
Farquhar Knob	47 52 40.18	89 59 23.77	L. S.	Final Rept.
	47°-48°	91°-92°		
Burlington	47 01 49.46	91 38 29.36	do	Do.
East Sawteeth	23 19.02	10 15.79	do	Do.
Split Rock	11 16.03	23 11.01	do	Do.
West Sawteeth	22 19.08	11 43.63	do	Do.

MINNESOTA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	46°-47° ° / "	91°-92° ° / "		
Buchanan	46 56 28.07	91 47 19.82	L. S.	Final Rept.
Lester	51 55.11	59 14.32	do	Do.
	46°-47°	92°-93°		
Minnesota Point, light-house	46 42 36.20	92 01 33.00	do	Do.
North base	45 27.89	04 43.26	do	Do.
Oneota	45 18.54	07 59.85	do	Do.
	45°-46°	93°-94°		
Mound View	45 05 30.53	93 10 02.11	C. & G. S.	
	44°-45°	92°-93°		
Hampton	44 36 36.74	92 56 26.73	do	
Prescott	46 40.86	45 41.59	do	
Red Wing : Spire Catholic church	33 44.64	31 49.65	L. S.	Do.
Astronomic monument				
Woodbury	54 51.97	56 38.02	C. & G. S.	
	44°-45°	93°-94°		
Buck Hill	44 43 22.90	93 17 04.84	do	
Hopkins	55 10.44	27 25.90	do	
Marcotta	48 52.32	02 56.48	do	
Prospect Park	58 06.38	12 36.28	do	
Ramsey	59 19.21	00 18.97	do	
St. Paul : North base	59 42.44	09 51.34	do	
South base	54 59.81	09 52.02	do	
SE. corner of custom-house	56 43.00	05 34.00	do	
Wallace	54 19.55	05 12.14	do	
Washburn Home	54 46.49	16 36.07	do	

IOWA.

	42°-43° ° / "	90°-91° ° / "		
Sherrill Mound	42 36 17.21	90 47 33.37	C. & G. S.	
	41°-42°	95°-96°		
Bluffs	41 14 32.44	95 50 35.43	Mo. R. C.	Rept. '91.
Council	16 32.75	51 09.91	do	Do.
Crescent	21 09.58	52 16.73	do	Do.
Henton	06 04.82	49 00.85	do	Do.
Loveland	30 08.67	53 16.76	do	Do.
Taylor	41 13.15	56 31.47	do	Do.
	40°-41°	91°-92°		
Boardman	40 24 39.68	91 26 23.95	Miss. R. C.	Rept. '84.
Hughes	24 38.06	24 09.13	do	Do.
Keokuk	24 34.70	22 44.81	do	Do.
Mrs. W. H. Sample's house	23 40.93	22 42.98	do	Rept. '88.
Presbyterian church spire	23 53.11	23 03.69	do	Do.
Unitarian church spire	23 49.32	22 47.62	do	Do.
Lower base	25 04.58	22 55.52	do	Rept. '84.
Upper base	25 43.51	23 16.34	do	Do.
Yellow Banks	24 24.65	29 20.13	do	Do.
	40°-41°	95°-96°		
Hamburg	40 33 20.06	95 37 40.83	Mo. R. C.	Rept. '91.
McCracken	40 27.16	42 12.33	do	Do.
Pugh	46 33.28	44 22.71	do	Do.
Quarry	56 27.62	47 10.92	do	Do.
Thurman	50 55.04	45 34.40	do	Do.

MISSOURI

	40°-41° ° / "	91°-92° ° / "		
Canton	40 07 46.38	91 31 19.63	Miss. R. C.	Rept. '88.
University	07 50.57	31 49.67	do	Rept. '84.
Congill	11 27.78	31 20.22	do	Do.
Fox River	21 34.82	35 20.87	do	Do.
Lagrange	02 46.88	29 58.45	do	Do.
	40°-41°	95°-96°		
Craig	40 13 00.05	95 22 43.21	Mo. R. C.	Rept. '91.
Langdon	22 29.30	31 56.12	do	Do.
Napier	02 45.22	14 37.39	do	Do.

MISSOURI—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	40°-41° ° / "	95°-96° ° / "		
Nishne	40 17 53.47	95 23 06.15	Mo. R. C	Rept. '91.
Phelps	26 57.68	34 07.44	do	Do.
	39°-40°	90°-91°		
Clarksville	39 22 24.42	90 54 37.25	Miss. R. C	Rept. '84.
Kilham	01 38.90	44 57.54	do	Do.
Knox	05 44.76	45 39.42	do	Do.
McLean	25 03.24	59 16.52	do	Do.
Saltpeter	15 15.73	49 37.99	do	Do.
	39°-40°	91°-92°		
Hannibal	39 41 19.73	91 19 23.43	do	Do.
Elevator, southeast gable	42 19.21	20 38.94	do	Rept. '88.
Heather	47 20.42	26 15.86	do	Rept. '84.
Louisiana	27 23.99	03 11.31	do	Do.
Northeast corner of high school building.	27 12.65	03 08.25	L. S	Final Rept.
Southeast corner of brick residence on northwest corner Noyes and Fourth streets.	27 15.20	03 07.40	do	Do.
Stone observing post in northwest corner of high school yard.	27 14.30	03 06.30	do	Do.
Nelson	52 20.76	30 06.58	Miss. R. C	Rept. '84.
Red House	36 28.96	12 53.24	do	Do.
Salt River	28 07.58	04 15.33	do	Do.
	39°-40°	94°-95°		
Amazonia	39 53 21.07	94 53 54.10	Mo. R. C	Bull. 122.
Halls	36 55.15	59 18.61	do	Do.
Iatan	27 41.08	58 00.81	do	Do.
Independence court-house	05 37.68	24 56.36	C. & G. S	
Kansas City :				
St. Patrick's church spire	06 08.04	35 19.19	do	
Transit				
Kenmoor	38 55.29	56 01.70	Mo. R. C	Do.
King Knob	43 06.93	51 35.96	do	Do.
Reese	29 58.30	59 39.89	do	Do.
St. Joe	48 31.34	52 11.90	do	Do.
Vienna	27 37.49	04 47.07	G. S	Do.
Westport, college spire	04 06.47	35 18.31	C. & G. S	
	39°-40°	95°-96°		
Forest City	39 58 27.88	95 10 54.30	Mo. R. C	Do.
Gordon	33 22.79	01 57.13	do	Do.
Nodaway	54 55.71	01 28.70	do	Do.
Payne	55 18.39	07 33.29	do	Do.
	38°-39°	90°-91°		
Barwise	38 54 59.25	90 16 05.50	Miss. R. C	Rept. '84.
Brickey	05 12.82	12 48.87	do	Do.
Cæsar	09 39.78	18 19.70	do	Do.
Correll	00 26.00	04 54.83	do	Do.
East base	56 43.38	25 43.16	do	Do.
Echele	54 33.62	18 58.00	do	Do.
Forder	30 39.64	17 32.83	do	Do.
Freeman	51 29.42	09 02.01	do	Do.
Halleck	28 12.42	55 24.10	C. & G. S	
Herculaneum	15 16.55	22 17.54	Miss. R. C	Do.
Insane asylum	36 13.99	16 45.37	do	Do.
Lynch	24 32.46	43 59.70	C. & G. S	
Magnolia	02 42.54	08 40.13	Miss. R. C	Do.
Merramee	24 23.78	19 36.79	do	Do.
Missouri River	48 39.97	07 49.21	do	Do.
Nicholson	54 00.65	13 09.85	do	Do.
Patterson	27 57.41	31 59.53	C. & G. S	
Portage	55 10.84	20 37.93	Miss. R. C	Do.
Ponrie	55 47.03	22 33.65	do	Do.
Robinson	45 30.68	11 18.10	do	Do.
St. Louis, Washington University	38 03.00	12 17.00	C. & G. S	
Shirley	50 48.33	07 22.12	Miss. R. C	Do.
Standpipe	40 13.59	12 31.51	do	Do.
Strong	52 57.31	11 50.73	do	Do.
Sulphur Springs	19 41.09	22 31.84	do	Do.
Terrapin	48 04.79	08 59.63	do	Do.
Twin Hollow	27 05.35	17 37.08	do	Do.
Watkins	52 05.69	10 38.65	do	Do.
Weper	54 27.33	14 29.76	do	Do.
West base	56 14.28	26 58.85	do	Do.
Winfield	59 18.39	44 19.22	do	Do.
	38°-39°	91°-92°		
Jacobs	38 26 22.93	91 16 09.42	C. & G. S	
Geyer	27 01.78	35 48.40	do	
Peters	27 51.32	03 45.43	do	

MISSOURI—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	38°-39° ° ' "	91°-92° ° ' "		
Pilot.....	38 20 15.99	91 47 55.15	C. & G. S.	
Winter.....	27 46.12	26 02.37	do	
	38°-39°	92°-93°		
Hughes.....	38 26 01.36	92 55 50.61	do	
Wright.....	46 01.63	22 28.27	Mo. R. C.	Bull. 122.
	38°-39°	93°-94°		
Caldwell.....	38 34 10.21	93 45 21.08	C. & G. S.	
Cook Knob, pole in cupola in Cook's ice house.	52 02.06	31 30.45	do	
Hazel Hill.....	53 46.08	45 05.57	do	
Heard.....	43 01.28	12 24.88	do	
High Point Tebo.....	34 39.15	34 18.80	do	
Kendrick.....	39 43.83	25 57.98	do	
Knob Noster.....	46 40.35	33 05.70	do	
Lamonte, Campbellite church spire.....	46 44.25	25 22.98	do	
Normal.....	45 37.89	44 15.08	do	
Schnackenburg.....	29 56.63	11 26.18	do	
Sedalia, spire.....	42 26.77	13 36.00	do	
	38°-39°	94°-95°		
Baker, Kingsville.....	38 45 41.91	94 04 11.78	do	
Belton, South Methodist church spire.....	48 37.64	31 48.65	do	
Bowler.....	53 20.98	23 38.30	do	
Butler, barn cupola.....	46 51.42	25 59.85	do	
Berry, Belton.....	49 18.89	33 32.45	do	
Chapel Hill.....	54 52.14	03 27.27	do	
Fulton, Harrisonville.....	38 48.46	18 33.07	do	
Hutton Mound.....	32 56.24	10 48.82	do	
North Mound.....	20 51.45	17 13.20	G. S.	Do.
Thornton.....	50 10.25	14 45.83	do	Do.
Corner Ts. 42 and 43, State line.....	28 43.66	36 44.57	do	Do.
Corner Ts. 40 and 41, Rs. 30 and 31.....	18 29.52	17 28.44	do	Do.
Corner Ts. 19 and 20, State line.....	20 47.52	36 45.42	do	Do.
Corner Ts. 17 and 18, State line.....	31 11.86	36 42.39	do	Do.
	37°-38°	89°-90°		
Backbone.....	37 44 48.74	89 39 53.09	Miss. R. C.	Rept. '84.
Bowles.....	01 02.61	12 31.18	do	Do.
Cape Girardeau.....	18 27.01	31 08.86	do	Rept. '88.
Normal school.....	18 45.14	31 53.17	do	Do.
Cape Lecroix.....	14 53.51	28 05.76	do	Rept. '84.
Commerce.....	08 27.52	26 13.19	do	Do.
Floral.....	20 50.38	28 25.53	do	Do.
Grand Chain.....	13 02.59	28 27.61	do	Do.
Hofner.....	10 05.44	27 06.25	do	Do.
Indian Creek.....	30 59.60	30 24.06	do	Do.
Killion.....	48 10.73	47 27.73	do	Do.
Lower base.....	49 28.52	43 34.53	do	Do.
Missouri Sister.....	04 41.99	17 00.56	do	Do.
Moccasin Springs.....	26 28.54	27 13.57	do	Do.
North base.....	14 26.69	27 49.10	do	Do.
Rowse.....	03 34.67	15 27.87	do	Do.
Rozier.....	51 50.03	54 54.35	do	Do.
Silica.....	36 41.72	31 11.11	do	Do.
South base.....	13 49.17	28 07.25	do	Do.
Taylor.....	02 51.93	14 15.28	do	Do.
Uncle Joe.....	11 51.36	28 07.18	do	Do.
Upper base.....	50 40.41	45 12.02	do	Do.
Vause.....	54 48.43	59 20.73	do	Do.
	37°-38°	90°-91°		
St. Genevieve, church spire.....	37 58 45.02	90 02 49.75	do	Rept. '88.
	37°-38°	93°-94°		
Bolivar:				
Astronomical pier.....	37 36 35.22	93 24 47.68	G. S.	Bull. 49.
Court-house dome.....	36 53.38	24 38.00	do	Do.
Pinnacle of schoolhouse.....	37 01.87	24 47.75	do	Do.
Methodist church spire.....	36 58.28	24 34.33	do	Do.
Southwest pinnacle Southwest Baptist College.	36 31.34	24 44.78	do	Do.
North Springfield:				
Astronomical pier.....	13 15.96	17 17.58	do	Do.
Ozark Hotel, flagstaff.....	13 51.56	17 16.69	do	Do.
Waterworks, flagstaff.....	14 03.26	17 35.36	do	Do.
Catholic church spire.....	13 42.01	17 05.25	do	Do.
Drury College chapel, spire.....	13 06.66	17 16.74	do	Do.
Center sec. 13, T. 29 N., R. 22 W.....	13 10.16	17 08.59	do	Do.
SW. corner sec. 7, T. 29 N., R. 21 W.....	13 35.95	16 34.74	do	Do.
SW. corner T. 30 N., R. 21 W.....	16 30.65	17 50.62	do	Do.
1/4 sec. corner W. side of sec. 1, T. 29 N., R. 22 W.	16 14.32	17 34.33	do	Do.
SW. corner sec. 1, T. 33 N., R. 23 W.....	36 47.93	24 44.95	do	Do.

MISSOURI—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	37°-38° ° / "	93°-94° ° / "		
NE. corner T. 33 N., R. 23 W.	37 37 38.25	93 23 35.02	G. S.	Bull. 49.
¼ sec. corner on S. side sec. 12, T. 33 N., R. 23 W.	36 48.25	25 31.45	do	Do.
	36°-37° ° / "	92°-93° ° / "		
Cedar	36 33 32.76	92 58 48.69	do	Bull. 122.
Hammond	45 37.92	59 59.53	do	Do.
	36°-37° ° / "	93°-94° ° / "		
Bald	36 39 13.89	93 17 45.27	do	Do.
Butterfield	43 43.96	54 48.91	do	Do.
Lohmer	39 56.00	42 32.43	do	Do.
Pilot Knob	32 46.34	32 46.49	do	Do.
Trout	36 34.49	08 47.74	do	Do.

NORTH DAKOTA.

	48°-49° ° / "	102°-103° ° / "		
Crow Flies High	48 02 19.38	102 41 31.33	Mo. R. C.	Rept. '91.
Elk Horn	04 15.94	44 52.26	do	Do.
Grinnell	10 27.76	57 18.59	do	Do.
Lone Butte	05 24.41	52 40.07	do	Do.
Stony Hill	02 54.45	34 58.63	do	Do.
Strawberry	10 00.23	53 15.92	do	Do.
White Earth	07 44.12	40 43.08	do	Do.
	48°-49° ° / "	103°-104° ° / "		
Bad Lands	48 03 27.61	103 27 15.48	do	Do.
Buford	01 01.49	58 03.31	do	Do.
Ehorst	03 27.28	32 06.26	do	Do.
Fire Hill	04 35.48	12 47.48	do	Do.
Geries	02 00.86	34 53.87	do	Do.
Harris	04 26.78	21 12.67	do	Do.
Jones Cut	06 00.05	44 57.51	do	Do.
Nesson	09 38.38	12 56.24	do	Do.
Reservation	00 05.75	47 25.34	do	Do.
Scott	05 21.90	37 36.16	do	Do.
Tobacco	06 46.02	03 57.17	do	Do.
Trenton	02 16.67	53 53.54	do	Do.
Williston	09 19.57	34 47.87	do	Do.
	47°-48° ° / "	100°-101° ° / "		
Iverson	47 09 08.89	100 52 19.96	do	Do.
Square Butte	03 00.07	56 09.54	do	Do.
Washburn	18 04.45	59 39.14	do	Do.
Wogan	00 45.43	49 25.10	do	Do.
	47°-48° ° / "	101°-102° ° / "		
Berthold	47 33 40.56	101 49 39.49	do	Do.
Chippewa	33 06.02	40 32.98	do	Do.
Coal Harbor	29 51.23	21 16.24	do	Do.
Cook	30 16.36	41 26.65	do	Do.
Emanuel	31 21.44	35 06.96	do	Do.
Guide meridian	29 39.66	46 46.49	do	Do.
Hancock	25 00.43	25 41.67	do	Do.
Hoffman	18 33.22	26 22.75	do	Do.
Lundquist	20 36.06	18 25.19	do	Do.
Mandan Lake	14 55.88	08 38.54	do	Do.
Ranch	12 56.94	02 49.83	do	Do.
Robinson	32 12.06	21 53.01	do	Do.
Stanton	16 24.60	22 44.04	do	Do.
Stevenson	35 46.98	27 08.57	do	Do.
Swensherm	18 46.31	16 32.32	do	Do.
Winslow	29 01.42	28 44.72	do	Do.
	47°-48° ° / "	102°-103° ° / "		
Cairn	47 30 17.60	102 02 55.77	do	Do.
Down	33 39.64	11 37.30	do	Do.
Independence	43 12.26	20 25.79	do	Do.
Indian Creek	45 33.30	33 30.34	do	Do.
Knife River	58 29.89	32 40.59	do	Do.
Little Missouri	37 21.25	18 29.59	do	Do.
Maneury	44 32.80	29 12.89	do	Do.
Mission	38 09.18	13 35.72	do	Do.
Oak Ridge	52 14.17	41 47.32	do	Do.
Saddle Mountain	51 19.75	40 27.67	do	Do.
Scoria	35 11.70	01 36.71	do	Do.
Second Ridge	50 12.49	31 00.20	do	Do.
Slide	45 58.77	14 55.11	do	Do.

NORTH DAKOTA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	47°-48°	103°-104°		
	° ' "	° ' "		
East base	47 59 49.98	103 56 52.94	Mo. R. C.	Rept. '91.
Glass Bluff	57 01.14	55 45.40	do	Do.
Lagoon	58 47.17	28 37.08	do	Do.
Plum	59 43.48	21 53.65	do	Do.
West base	59 36.26	59 39.28	do	Do.
	46°-47°	100°-101°		
	° ' "	° ' "		
Battle Creek	46 08 44.72	100 39 07.00	do	Do.
Beaver Creek	17 08.40	31 30.62	do	Do.
Bismarck	49 12.34	45 08.11	do	Do.
Cannon Ball	23 55.25	38 19.27	do	Do.
Cathead	06 52.45	32 43.38	do	Do.
Fort Abraham Lincoln	46 10.00	50 57.00	Engr. Corps ..	Rept. '75.
Fort Rice	31 47.13	41 12.47	Mo. R. C.	Rept. '91.
Fort Yates	05 59.44	38 07.42	do	Do.
Gayton	23 44.04	31 34.64	do	Do.
Givens	19 54.15	34 54.54	do	Do.
Glencoe	36 15.59	30 05.23	do	Do.
Harmon	58 40.13	57 15.11	do	Do.
Kayhall	44 03.89	40 33.96	do	Do.
Lincoln	46 12.23	51 03.22	do	Do.
Little Beaver	12 11.61	32 44.64	do	Do.
Little Hart	41 56.32	49 09.74	do	Do.
Mandan	51 08.07	55 05.04	do	Do.
Marysville	51 06.89	48 06.99	do	Do.
McIntyre	28 27.70	32 11.73	do	Do.
McRay	00 54.01	30 40.28	do	Do.
North base	48 10.89	48 14.58	do	Do.
Riverside	37 22.72	43 54.03	do	Do.
South base	45 34.60	47 00.60	do	Do.
Sperry	57 05.97	52 19.87	do	Do.
Van Solen	16 03.91	37 28.84	do	Do.
Winona	03 55.20	33 02.12	do	Do.
	45°-46°	100°-101°		
	° ' "	° ' "		
Fire Heart	45 59 39.55	100 34 41.14	do	Do.

SOUTH DAKOTA.

	45°-46°	100°-101°		
	° ' "	° ' "		
Ashley	45 37 45.15	100 26 16.76	Mo. R. C.	Rept. '91.
Aske	33 46.22	22 53.90	do	Do.
Bunker Hill	06 21.61	14 34.37	do	Do.
Bennett	24 00.83	13 28.60	do	Do.
Blue Blanket	29 20.96	24 48.56	do	Do.
Blume	41 19.45	20 39.18	do	Do.
Box Elder	46 05.12	24 20.98	do	Do.
Campbell	41 08.63	14 47.46	do	Do.
Charger	03 20.84	21 00.95	do	Do.
Curlew	25 18.25	20 20.10	do	Do.
Doerschlag	58 01.94	27 14.98	do	Do.
Fox Island	28 29.75	18 10.20	do	Do.
Grand River	32 47.94	29 49.28	do	Do.
Kirkland	46 07.63	17 31.17	do	Do.
La Grace	53 49.18	23 27.76	do	Do.
Le Beau	19 28.54	17 22.61	do	Do.
Martin	55 43.20	32 47.35	do	Do.
McKinley	20 12.18	12 33.97	do	Do.
Roth	36 11.35	20 48.81	do	Do.
Scranton	14 36.96	13 32.42	do	Do.
St. Benedict	50 30.75	30 54.23	do	Do.
St. Stephen	12 46.10	19 01.65	do	Do.
	44°-45°	99°-100°		
	° ' "	° ' "		
Big Bend	44 13 46.16	99 37 31.62	do	Do.
Burnt Ridge	01 19.73	38 53.90	do	Do.
Cedar River	05 42.40	54 28.06	do	Do.
Chapelle Creek	16 29.61	54 01.86	do	Do.
Neck	08 15.29	35 36.32	do	Do.
Reynolds	10 45.69	46 09.14	do	Do.
Fort Thompson	06 02.46	26 44.92	do	Do.
Wolf Creek	01 57.01	18 10.48	do	Do.
	44°-45°	100°-101°		
	° ' "	° ' "		
Artichoke	44 50 27.93	100 21 19.01	do	Do.
Bad River	19 50.86	20 39.25	do	Do.
Barth	20 38.89	14 03.58	do	Do.

SOUTH DAKOTA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	44°-45°			100°-101°				
	°	'	"	°	'	"		
Brown Hill.....	44	25	39.58	100	27	23.68	Mo. R. C.....	Rept. '91.
Cemetery.....		21	54.71		18	19.73	do.....	Do.
East base.....		20	46.24		17	07.56	do.....	Do.
Fairbank.....		46	43.75		25	45.40	do.....	Do.
Farm Island.....		13	24.37		14	03.51	do.....	Do.
Ferry.....		24	31.84		31	20.83	do.....	Do.
Fielder.....		31	56.36		38	10.84	do.....	Do.
Forest City.....		59	15.11		18	07.48	do.....	Do.
Fort.....		22	04.98		24	14.87	do.....	Do.
Fort Bennett.....		41	38.25		41	46.38	do.....	Do.
Fort George.....		14	21.71		02	04.22	do.....	Do.
Ingham.....		29	28.34		29	24.58	do.....	Do.
Jacques.....		18	05.28		02	08.00	do.....	Do.
Narselles.....		17	15.80		07	21.06	do.....	Do.
Pascal.....		54	47.75		26	49.60	do.....	Do.
Perry.....		20	15.48		08	45.29	do.....	Do.
Pierre.....		22	50.28		20	26.44	do.....	Do.
Plateau.....		19	32.50		18	01.60	do.....	Do.
Plumb Island.....		51	37.13		34	44.83	do.....	Do.
Rousseau.....		19	26.16		05	16.95	do.....	Do.
Travessy.....		59	26.12		27	41.83	do.....	Do.
Snake Butte.....		25	36.03		21	45.15	do.....	Do.
Stony Hill.....		28	19.00		23	57.26	do.....	Do.
Sully.....		41	54.74		29	06.48	do.....	Do.
West base.....		21	14.97		19	47.76	do.....	Do.
	44°-45°			103°-104°				
Bear Butte.....	44	28	34.40	103	25	08.90	G. S.....	Bull. 122.
Costello.....		18	12.90		05	26.80	do.....	Do.
Custer.....		14	41.40		43	41.10	do.....	Do.
Deadwood, post-office.....		22	34.00		43	18.60	L. S.....	Final Rept.
Dunning.....		05	20.30		03	32.30	G. S.....	Bull. 122.
East base.....		07	04.00		04	35.50	do.....	Do.
Mitchell.....		09	53.80		06	20.10	do.....	Do.
Piedmont.....		13	55.80		21	40.50	do.....	Do.
Rapid, astronomical pier.....		04	45.24		12	59.28	do.....	Do.
Sammis.....		03	07.10		14	16.50	do.....	Do.
West base.....		07	09.20		10	29.10	do.....	Do.
White.....		06	53.70		14	12.00	do.....	Do.
	43°-44°			98°-99°				
Chicot.....	43	03	03.67	98	41	30.51	Mo. R. C.....	Rept. '91.
Kyle.....		18	02.59		51	58.75	do.....	Do.
Leonard.....		08	43.72		37	39.33	do.....	Do.
Mule Head.....		13	20.61		56	05.37	do.....	Do.
Wheeler.....		12	20.63		48	26.42	do.....	Do.
Whetstone.....		06	35.91		50	04.30	do.....	Do.
White Swan.....		03	52.46		29	21.42	do.....	Do.
	43°-44°			99°-100°				
Badger Creek.....	43	59	10.55	99	28	45.86	do.....	Do.
Bijou.....		30	51.66		15	26.56	do.....	Do.
Bluff.....		56	24.00		19	42.32	do.....	Do.
Boland.....		23	22.68		01	31.08	do.....	Do.
Brickkiln.....		23	46.97		12	49.96	do.....	Do.
Brulé.....		47	06.18		27	05.15	do.....	Do.
Chamberlain.....		47	23.66		19	17.70	do.....	Do.
Cologne.....		20	38.83		08	30.92	do.....	Do.
Durex.....		27	52.74		19	56.52	do.....	Do.
Fort Lookout.....		53	29.15		23	38.34	do.....	Do.
Hamilton.....		16	25.20		02	18.26	do.....	Do.
Heaton.....		26	46.83		07	42.65	do.....	Do.
Indian.....		37	49.46		30	13.57	do.....	Do.
Prichard.....		51	12.80		17	24.94	do.....	Do.
Rosebud.....		31	47.39		24	37.69	do.....	Do.
Willrodt.....		38	56.08		19	37.74	do.....	Do.
	43°-44°			102°-103°				
Thompson Butte.....	43	55	07.00	102	58	42.50	G. S.....	Bull. 122.
	43°-44°			103°-104°				
Bradley.....	43	25	08.50	103	37	07.00	do.....	Do.
Cheyenne.....		35	52.60		06	43.50	do.....	Do.
Custer.....		45	56.44		36	17.30	Engr. Corps..	Rept. '78.
Fossil.....		12	21.52		30	00.00	G. S.....	Bull. 122.
Gap.....		30	51.00		22	03.40	do.....	Do.
Harney Peak.....		51	59.60		31	27.30	do.....	Do.
State Line.....		00	04.50		16	02.70	do.....	Do.
Windy.....		14	35.00		11	00.50	do.....	Do.

NEBRASKA.

Name.	Latitude.			Longitude.			Authority.	Reference.
	42°-43°			96°-97°				
	°	'	"	°	'	"		
Baird	42	20	59.31	96	30	14.14	Mo. R. C.	Rept. '91.
Blackbird		04	45.93		17	54.86	do	Do.
Emerson		30	04.95		28	06.87	do	Do.
Grant		10	32.11		00	33.26	do	Do.
Hall		36	42.45		30	25.34	do	Do.
Hedges		19	08.27		08	07.10	do	Do.
Ionia		39	19.78		46	02.25	do	Do.
Johnson		49	07.40		41	56.12	do	Do.
Round Cap		29	25.68		35	37.66	do	Do.
Ryan		42	14.28		53	02.74	do	Do.
Sargeants		24	31.50		21	04.78	do	Do.
Spirit Mound		52	26.44		57	31.90	do	Do.
Triloba		33	30.29		40	02.36	do	Do.
Westfield		41	13.31		33	21.77	do	Do.
Winnebago		15	57.93		22	27.17	do	Do.
	42°-43°			97°-98°				
Bon Homme	42	52	20.47	97	40	19.47	do	Do.
Bow Creek		46	03.82		07	32.98	do	Do.
Covell		49	53.77		56	31.20	do	Do.
Herrick		47	59.94		39	10.81	do	Do.
Kelley		47	50.98		57	26.60	do	Do.
Lakeport		53	20.24		33	08.55	do	Do.
Lost Creek		46	56.68		54	03.94	do	Do.
Niobrara		44	01.46		57	49.24	do	Do.
North base		47	54.41		55	33.18	do	Do.
Pit		47	50.29		31	02.84	do	Do.
Santee		47	58.11		47	10.61	do	Do.
Schmidt		48	15.38		19	48.03	do	Do.
South base		46	01.81		57	24.49	do	Do.
Springfield		53	07.24		50	34.33	do	Do.
Welby		55	57.63		19	00.38	do	Do.
	42°-43°			98°-99°				
Arneson	42	48	29.35	98	02	54.14	do	Do.
Bruce		53	45.01		24	37.50	do	Do.
Chouteau		52	17.12		08	37.97	do	Do.
Conger		55	50.48		13	42.09	do	Do.
Harrison		57	11.06		34	47.52	do	Do.
Ponca		46	47.56		12	29.06	do	Do.
Ward		45	07.05		06	25.15	do	Do.
	42°-43°			103°-104°				
Camp Robinson, flagstaff	42	39	48.33	103	27	45.00	Engr. Corps.	Rept. '78.
	41°-42°			95°-96°				
Bellevue	41	09	47.79	95	53	57.06	do	Bull. 122.
Bluffs		14	32.44		50	35.43	do	Rept. '91.
Council		16	32.75		51	09.91	do	Do.
Crescent		21	09.58		52	16.73	do	Do.
Douglas		23	40.89		58	33.65	do	Do.
Henton		06	04.82		49	00.85	do	Do.
High School		15	36.11		56	38.14	do	Do.
Mormon		48	52.12		59	43.85	do	Do.
Omaha		16	50.46		57	33.27	do	Do.
Platte		02	08.56		53	55.42	Mo. R. C.	Bull. 122.
Taylor		41	13.10		56	31.48	do	Rept. '91.
U. S. C. and G		15	33.94		56	37.22	do	Do.
	41°-42°			96°-97°				
Bench	41	33	11.12	96	07	45.58	do	Do.
Blair		31	05.32		07	05.09	do	Do.
East base		36	49.41		06	50.33	do	Do.
Herman		38	04.65		12	24.07	do	Do.
Sandig		56	32.87		14	31.41	do	Do.
Tekamah		46	16.27		13	34.99	do	Do.
West		36	49.19		09	40.18	do	Do.
	41°-42°			100°-101°				
North Platte, astronomical monu- ment.	41	08	18.33	100	45	53.14	Wheeler	Final Rept.
	41°-42°			102°-103°				
Fort Sidney, astronomical monu- ment.	41	08	36.75	102	58	13.32	do	Do.
	41°-42°			103°-104°				
Bushnell, transit	41	13	54.00	103	52	56.25	C. & G. S.	Rept. '84.
	40°-41°			95°-96°				
Arago	40	08	13.84	95	26	39.51	Mo. R. C.	Rept. '91.
Brownville		24	30.39		39	36.59	do	Do.
Calumet		53	40.80		53	21.02	do	Do.
City		36	32.01		47	59.14	do	Do.

NEBRASKA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	40°-41° ° ' "	95°-96° ° ' "		
Devoir	40 14 37.26	95 31 16.01	Mo. E. C.	Rept. '91.
Jones	49 07.05	52 05.56	do	Do.
Nemaha	01 08.48	20 59.11	do	Do.
Otoe	39 16.90	49 03.08	do	Do.
Peru	28 10.98	42 11.39	do	Do.
St. Deroi	16 44.45	34 18.72	do	Do.
	40°-41° ° ' "	97°-98° ° ' "		
State line Kansas and Nebraska	40 00 12.52	97 55 54.66	G. S.	Bull. 122.

KANSAS.

	39°-40° ° ' "	94°-95° ° ' "		
Anderson	39 41 56.86	94 58 59.13	Mo. R. C.	Rept. '91.
Amazonia	53 21.07	53 54.10	do	Do.
Fort Leavenworth	21 19.12	54 51.84	Engr. Corps ..	Do.
Fox	50 46.35	59 45.32	Mo. R. C.	Do.
Halls	36 55.15	59 18.61	do	Do.
Iatan	27 41.08	58 00.81	do	Do.
Kenmoor	38 55.29	56 01.70	do	Do.
Kickapoo	24 22.13	58 25.79	do	Do.
Kings Knob	43 06.93	51 35.96	do	Do.
Reese	29 58.30	59 39.89	do	Do.
Sheridan	22 16.45	55 52.67	do	Do.
St. Joe	48 31.34	52 11.90	do	Do.
Wathena	45 09.89	57 07.31	do	Do.
Weston	24 10.55	53 45.96	do	Do.
	39°-40° ° ' "	95°-96° ° ' "		
Agency	39 14 44.10	95 50 10.20	G. S.	Bull. 122.
Atchison	35 42.56	05 53.20	Mo. R. C.	Rept. '91.
Cedar	22 20.01	33 13.35	G. S.	Bull. 122.
Cope	17 13.39	36 25.64	do	Do.
Eckman	02 37.37	00 05.19	C. & G. S.	Do.
Forest City	58 27.88	10 54.30	Mo. R. C.	Rept. '91.
Geary	38 54.56	02 55.52	do	Do.
Gordon	33 22.79	01 57.13	do	Do.
Lecompton	00 06.17	24 21.74	G. S.	Bull. 122.
Lookout	53 26.71	10 04.96	Mo. R. C.	Rept. '91.
Meriden	11 54.86	34 40.64	G. S.	Bull. 122.
Meers	51 28.21	05 13.09	Mo. R. C.	Rept. '91.
Newman	07 11.39	28 57.02	G. S.	Bull. 122.
Nodaway	54 55.71	01 28.70	Mo. R. C.	Rept. '91.
Oak Mills	26 56.54	01 07.91	do	Do.
Ozawkie	10 24.10	19 57.30	G. S.	Bull. 122.
Parry	06 56.78	20 53.40	do	Do.
Payne	55 18.39	07 33.29	Mo. R. C.	Rept. '91.
Pottawatomie	24 52.00	50 48.21	G. S.	Bull. 122.
Railroad	19 26.47	42 48.38	do	Do.
Rock Creek	15 56.26	31 17.35	do	Do.
Skimmerhorn	13 57.05	41 41.87	do	Do.
Snyder	31 34.23	06 02.24	Mo. R. C.	Rept. '91.
Soldier	21 19.29	57 35.63	G. S.	Bull. 122.
White Cloud	57 39.99	16 25.02	Mo. R. Co.	Rept. '91.
Windmill	05 02.12	12 35.59	G. S.	Bull. 122.
SE. corner sec. 21, T. 7, R. 14	25 15.38	50 54.35	do	Do.
SW. corner sec. 1, T. 11, R. 17	07 00.46	28 59.40	do	Do.
SW. corner sec. 15, T. 12, R. 18	00 06.13	24 33.79	do	Do.
SW. corner sec. 25, T. 9, R. 15	13 56.07	42 00.24	do	Do.
NW. corner sec. 26, T. 8, R. 15	19 34.45	43 07.45	do	Do.
NW. corner sec. 27, T. 9, R. 14	14 47.01	49 55.40	do	Do.
NE. corner sec. 19, T. 10, R. 19	10 25.77	19 43.14	do	Do.
N. $\frac{1}{4}$ corner sec. 7, T. 11, R. 19	07 03.40	20 42.15	do	Do.
NE. corner sec. 6, T. 12, R. 21	02 42.60	00 03.84	do	Do.
NW. corner sec. 11, T. 9, R. 16	17 23.86	36 26.06	do	Do.
NW. corner sec. 15, T. 8, R. 13	21 45.40	57 36.61	do	Do.
E. $\frac{1}{4}$ corner sec. 16, T. 9, R. 17	16 05.63	30 57.47	do	Do.
E. $\frac{1}{4}$ corner sec. 20, T. 11, R. 20	04 54.57	12 21.73	do	Do.
E. $\frac{1}{4}$ corner sec. 7, T. 8, R. 17	22 12.42	33 12.80	do	Do.
Center corner sec. 12, T. 10, R. 16	11 44.71	34 46.93	do	Do.
	39°-40° ° ' "	96°-97° ° ' "		
Blaine	39 29 42.52	96 19 07.22	do	Do.
Fostoria	28 48.46	26 44.12	do	Do.
Leonardville	22 53.20	47 19.91	do	Do.
Louisville	22 30.40	20 48.35	do	Do.
Olesburg	26 19.60	32 45.05	do	Do.

KANSAS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	39°-40° ° ' "	96°-97° ° ' "		
Randolph	39 32 02.03	96 44 44.33	G. S.	Bull. 122.
Springside	32 55.57	30 28.01	do	Do.
St. Marys	16 31.60	06 15.10	do	Do.
Stockdale	20 44.26	32 01.20	do	Do.
SE. corner sec. 29, T. 6, R. 10	29 39.48	18 50.25	do	Do.
S. $\frac{1}{4}$ sec. 17, T. 7, R. 8	26 12.84	32 51.35	do	Do.
SW. corner sec. 5, T. 8, R. 6	22 47.20	47 34.08	do	Do.
NE. corner sec. 6, T. 7, R. 9	28 48.65	26 40.66	do	Do.
N. $\frac{1}{4}$ corner sec. 7, T. 8, R. 10	22 41.20	20 32.57	do	Do.
N. $\frac{1}{4}$ corner sec. 15, T. 6, R. 6	32 17.77	44 44.30	do	Do.
NW. corner sec. 17, T. 9, R. 12	16 33.52	06 35.33	do	Do.
NW. corner sec. 21, T. 8, R. 8	20 59.72	32 16.32	do	Do.
	39°-40°	97°-98°		
Butler	39 15 25.88	97 15 33.67	do	Do.
Concordia	31 28.03	40 34.64	do	Do.
Frey	01 31.84	10 24.56	do	Do.
Jamestown	39 23.77	50 40.98	do	Do.
Minersville	40 10.09	41 58.48	do	Do.
Monument	13 33.24	30 05.41	do	Do.
Renshawe	33 37.45	11 47.30	do	Do.
Scottsville	32 26.99	57 22.31	do	Do.
Sulphur Springs	24 36.77	30 42.37	do	Do.
Table Mound	18 44.74	16 36.81	do	Do.
Thompson	04 19.49	49 45.44	C. & G. S.	
Vine Creek	06 11.06	23 23.18	do	
Wayne	41 45.81	30 20.34	G. S.	Do.
Wilmer	07 20.93	02 22.80	do	Do.
Center corner sec. 11, T. 12, R. 2	01 31.95	10 33.73	do	Do.
NW. corner sec. 13, T. 11, R. 1	06 15.63	23 23.79	do	Do.
SE. corner sec. 1, T. 11, R. 3	07 10.80	02 13.08	do	Do.
W. corner sec. 36, T. 9, R. 2 W	13 27.80	30 12.60	do	Do.
One-fourth corner secs. 24 and 19, T. 9, Rs. 1 and 2 E.	15 27.02	15 32.88	do	Do.
SE. corner sec. 35, T. 8, R. 1 E	18 29.10	16 36.70	do	Do.
S. $\frac{1}{4}$ corner sec. 26, T. 7, R. 2	24 35.86	30 43.88	do	Do.
N. $\frac{1}{4}$ corner sec. 20, T. 6, R. 3	31 34.49	40 34.29	do	Do.
S. $\frac{1}{4}$ corner sec. 11, T. 6, R. 6	32 24.73	57 25.56	do	Do.
E. corner sec. 11, T. 6, R. 6	32 38.69	09 16.32	do	Do.
S. $\frac{1}{4}$ corner sec. 35, T. 4, R. 5	39 17.65	50 50.43	do	Do.
S. $\frac{1}{4}$ corner sec. 30, T. 4, R. 3	40 10.17	41 50.37	do	Do.
NE. corner sec. 23, T. 4, R. 2 W	41 59.00	29 46.70	do	Do.
	39°-40°	98°-99°		
Blue Hill	39 20 34.43	98 19 01.13	do	Do.
Cemetery	35 51.53	10 25.06	do	Do.
Church	20 52.77	06 06.93	do	Do.
Hardilee	50 57.55	57 03.13	do	Do.
Lawrence Creek	31 17.82	51 28.82	do	Do.
Lincoln	05 34.63	05 56.86	C. & G. S.	
Meade Ranch or Tree Will	13 32.79	32 31.61	do	
Old well	36 47.61	34 00.86	G. S.	Do.
Pointed Hill	44 21.20	05 42.48	do	Do.
School	39 23.13	42 38.01	do	Do.
Tipton	21 38.54	31 57.62	do	Do.
Waldo	10 00.77	49 52.37	C. & G. S.	
Corner secs. 15, 16, 21, 22, T. 8, R. 7	21 04.73	05 50.81	G. S.	Do.
E. $\frac{1}{4}$ corner sec. 15, T. 8, R. 11	21 39.38	31 38.08	do	Do.
W. $\frac{1}{4}$ corner sec. 23, T. 6, R. 14	31 09.68	51 32.13	do	Do.
SW. corner sec. 24, T. 5, R. 8	35 51.40	10 32.90	do	Do.
SE. corner sec. 16, T. 5, R. 11	36 44.32	33 40.50	do	Do.
N. $\frac{1}{4}$ corner sec. 3, T. 4, R. 7	44 32.04	05 47.87	do	Do.
W. $\frac{1}{4}$ corner sec. 30, T. 2, R. 14	51 06.93	57 15.75	do	Do.
	39°-40°	99°-100°		
Blue Mound	39 50 17.51	99 09 21.08	do	Do.
Densmore	35 22.38	41 51.48	do	Do.
Engstrom	34 43.59	00 06.57	do	Do.
Plaster Mound	46 18.67	30 21.19	do	Do.
Rock Mound	35 41.72	28 22.30	do	Do.
Stahl	44 00.81	49 03.34	do	Do.
Twin Mound	36 52.73	18 49.82	do	Do.
Windmill	33 02.28	54 10.34	do	Do.
N. $\frac{1}{4}$ corner sec. 34, T. 5, R. 15	35 01.40	00 03.34	do	Do.
NW. corner sec. 28, T. 5, R. 19	35 52.18	28 41.34	do	Do.
S. $\frac{1}{4}$ corner sec. 14, T. 5, R. 18	36 44.73	19 06.61	do	Do.
SE. corner sec. 5, T. 4, R. 22	43 38.57	48 55.11	do	Do.
N. $\frac{1}{4}$ corner sec. 32, T. 2, R. 16	50 39.66	09 04.78	do	Do.
	39°-40°	100°-101°		
Lenora	39 34 40.17	100 02 06.47	do	Do.
Wakeman	42 08.15	00 41.09	do	Do.
SW. corner sec. 33, T. 5, R. 24	34 05.50	02 23.00	do	Do.

KANSAS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	38°-39°			94°-95°				
	°	'	"	°	'	"		
Ellison.....	38	28	52.14	94	41	24.12	G. S.	Bull. 122.
Lenexa, Methodist Episcopal church.....		57	49.10		44	20.00	do	Do.
Long Mound.....		30	30.94		36	54.35	do	Do.
McCook.....		20	49.60		56	26.04	do	Do.
Osawatomie, insane asylum.....		30	50.86		56	19.64	do	Do.
Wooded Mound.....		20	00.55		37	15.90	do	Do.
Corner Ts. 42 and 43, State line.....		28	43.66		36	44.57	do	Do.
Corner Ts. 40 and 41, Rs. 30 and 31.....		18	29.52		17	28.44	do	Do.
Corner Ts. 19 and 20, Rs. 22 and 23.....		20	48.72		55	02.97	do	Do.
Corner Ts. 19 and 20, State line.....		20	47.52		36	45.42	do	Do.
Corner Ts. 18 and 19, Rs. 24 and 25.....		26	02.63		41	43.13	do	Do.
Corner Ts. 17 and 18, Rs. 22 and 23.....		31	16.29		55	03.33	do	Do.
Corner Ts. 17 and 18, State line.....		31	11.86		36	42.39	do	Do.
	38°-39°			95°-96°				
Allen.....	38	23	26.62	95	45	13.55	do	Do.
Blue Mound.....		54	20.72		10	53.95	do	Do.
Calvert.....		25	10.89		56	56.69	do	Do.
Duval.....		22	48.40		38	11.72	do	Do.
Emerald, cross on church.....		23	13.58		27	09.65	do	Do.
Filmore.....		27	26.86		46	25.60	do	Do.
Lawrence University.....		57	30.48		14	36.32	do	Do.
Loamas.....		27	15.04		27	30.12	do	Do.
Richmond, cupola of church.....		24	14.64		15	10.71	do	Do.
Rock Mound.....		20	09.52		31	10.36	do	Do.
Roky.....		30	28.72		40	19.64	do	Do.
Scipio, Dutch college.....		22	00.30		13	00.18	do	Do.
Sebo, schoolhouse.....		25	07.59		51	29.45	do	Do.
Wilton.....		30	37.34		08	50.00	do	Do.
White.....		23	57.08		03	51.80	do	Do.
SE. corner sec. 36, T. 12, R. 19.....		57	30.06		14	28.13	do	Do.
SW. corner sec. 22, T. 13, R. 20.....		54	00.74		11	08.03	do	Do.
Corner Ts. 20 and 21, Rs. 19 and 20.....		15	39.10		14	54.33	do	Do.
Corner Ts. 19 and 20, Rs. 19 and 20.....		20	52.61		14	53.47	do	Do.
Corner Ts. 19 and 20, Rs. 16 and 17.....		20	53.15		34	53.15	do	Do.
Corner Ts. 19 and 20, Rs. 14 and 15.....		20	51.74		48	07.69	do	Do.
Corner Ts. 18 and 19, Rs. 17 and 18.....		26	06.60		28	14.58	do	Do.
Corner Ts. 18 and 19, Rs. 14 and 15.....		26	05.34		48	06.91	do	Do.
Corner Ts. 18 and 19, Rs. 13 and 14.....		26	05.58		54	45.04	do	Do.
Corner Ts. 17 and 18, Rs. 15 and 16.....		31	23.42		41	29.02	do	Do.
Corner Ts. 17 and 18, Rs. 20 and 21.....		31	19.21		08	15.30	do	Do.
	38°-39°			96°-97°				
Baker.....	38	28	52.41	96	28	21.28	do	Do.
Cattle Ranch.....		26	28.24		37	03.25	do	Do.
Chicago Mound.....		21	10.91		04	08.52	do	Do.
Cottonwood Falls, cupola of court-house.....		22	18.47		32	28.30	do	Do.
Emporia, cupola of State normal school.....		24	50.96		10	47.52	do	Do.
Florence.....		15	57.32		54	53.86	do	Do.
Jacobs Mound.....		18	57.82		24	11.58	do	Do.
Messer.....		16	12.26		40	49.00	do	Do.
Newhall.....		10	30.13		53	46.84	do	Do.
Plumb.....		30	34.76		01	43.20	do	Do.
St. Johns.....		09	13.46		59	58.46	do	Do.
Stubbs.....		28	48.56		18	08.04	do	Do.
Tedro.....		19	34.46		37	38.01	do	Do.
Weichaus.....		21	52.57		43	56.30	do	Do.
Corner Ts. 20 and 21, Rs. 5 and 6.....		15	45.68		49	07.73	do	Do.
Corner Ts. 20 and 21, Rs. 6 and 7.....		15	45.39		42	29.86	do	Do.
Corner Ts. 17 and 18, Rs. 12 and 13.....		31	21.70		01	24.07	do	Do.
Corner Ts. 18 and 19, Rs. 7 and 8.....		26	11.61		35	50.45	do	Do.
Corner Ts. 19 and 20, Rs. 6 and 7.....		20	57.83		42	30.25	do	Do.
Corner Ts. 19 and 20, Rs. 12 and 13.....		20	54.26		01	25.50	do	Do.
Corner Ts. 19 and 20, Rs. 7 and 8.....		20	57.74		35	52.40	do	Do.
Corner Ts. 20 and 21, Rs. 4 and 5.....		15	45.45		55	45.11	do	Do.
Corner Ts. 17 and 18, Rs. 8 and 9.....		31	23.60		27	51.51	do	Do.
	38°-39°			97°-98°				
Bennett.....	38	10	32.99	97	16	03.24	do	Do.
Black Kettle.....		08	52.10		33	43.00	do	Do.
Dunkard.....		13	28.69		10	06.06	do	Do.
Dwarf.....		04	24.78		39	51.21	do	Do.
Herron.....		14	27.16		01	23.46	do	Do.
Hesston.....		08	30.86		25	38.62	do	Do.
Iron Mound.....		48	34.58		30	42.85	C. & G. S.	
Leslie.....		08	39.43		47	17.01	G. S.	Do.
Newt.....		06	44.73		11	58.24	do	Do.
Newton.....		02	58.56		20	40.06	do	Do.
Royer.....		10	09.10		20	09.84	do	Do.
Ruth.....		03	30.50		29	40.05	do	Do.

KANSAS—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	38°-39°			97°-98°				
	°	'	"	°	'	"		
Sand Hill.....	38	09	38.57	97	56	47.08	G. S.	Bull. 122.
Sheep Ranch.....		04	10.15		48	42.82	do	Do.
Walton.....		07	58.43		14	02.11	do	Do.
SE. corner sec. 36, T. 21, R. 1 E.....		10	27.58		15	44.98	do	Do.
SE. corner sec. 36, T. 22, R. 1 E.....		05	10.40		15	46.12	do	Do.
SE. corner sec. 8, T. 22, R. 2.....		08	40.37		33	17.20	do	Do.
SW. corner sec. 8, T. 22, R. 4.....		08	39.22		47	35.89	do	Do.
SW. corner sec. 4, T. 23, R. 3 W.....		04	18.44		39	50.32	do	Do.
SW. corner sec. 13, T. 21, R. 2 E.....		13	04.86		10	10.83	do	Do.
SW. corner sec. 33, T. 21, R. 1 E.....		10	24.77		20	09.69	do	Do.
Township corner.....		05	12.73		15	46.66	do	Do.
NE. corner sec. 13, T. 23, R. 5 W.....		03	24.96		48	38.43	do	Do.
NE. corner sec. 16, T. 22, R. 1 W.....		08	39.46		25	33.46	do	Do.
NE. corner sec. 16, T. 23, R. 1 E.....		02	57.72		20	38.70	do	Do.
	38°-39°			98°-99°				
Ackerman.....	38	07	21.59	98	50	45.32	do	Do.
Allon.....		49	41.74		52	20.46	C. & G. S.	
Bunker Hill.....		52	20.26		42	18.52	do	
Cactus.....		24	17.00		52	06.63	G. S.	Do.
Drifting Sand.....		09	44.89		26	51.08	do	Do.
Ellsworth.....		43	48.00		13	35.00	C. & G. S.	
Golden Belt.....		58	48.25		18	25.72	do	
Heath.....		50	45.10		02	59.70	do	
Lyons.....		19	51.93		08	43.70	G. S.	Do.
Millet.....		18	01.57		21	23.26	do	Do.
Mound.....		13	52.48		47	04.24	do	Do.
Pasture.....		22	23.95		39	33.57	do	Do.
Raymond.....		17	36.29		24	12.15	do	Do.
Sterling.....		13	14.64		12	24.26	do	Do.
Two.....		03	21.56		01	27.49	do	Do.
Wilson.....		51	55.97		29	18.17	C. & G. S.	
SW. corner sec. 16, T. 21, R. 8.....		13	00.15		12	53.68	G. S.	Do.
SW. corner sec. 23, T. 20, R. 10.....		17	23.38		24	20.49	do	Do.
SE. corner sec. 36, T. 20, R. 12.....		15	37.92		35	22.11	do	Do.
NE. corner sec. 16, T. 19, R. 14.....		24	17.21		51	56.28	do	Do.
NE. corner sec. 18, T. 21, R. 13.....		13	54.42		47	01.07	do	Do.
NE. corner sec. 12, T. 20, R. 8.....		19	57.41		08	43.50	do	Do.
NW. corner sec. 8, T. 22, R. 10.....		10	22.12		27	06.43	do	Do.
NW. corner sec. 28, T. 19, R. 12.....		22	33.39		39	46.92	do	Do.
NW. corner sec. 18, T. 23, R. 7.....		03	24.26		01	49.70	do	Do.
	38°-39°			99°-100°				
Blue Hill.....	38	59	01.93	99	05	58.46	C. & G. S.	
Burdette.....		08	43.23		32	46.31	G. S.	Do.
Cheese Factory.....		01	43.15		38	42.51	do	Do.
Dugout.....		15	21.16		13	44.80	do	Do.
Fair Mount.....		40	35.70		00	17.42	do	Do.
Frank.....		12	19.09		43	16.18	do	Do.
Garfield.....		06	29.63		13	56.68	do	Do.
Hays.....		54	56.66		16	16.86	C. & G. S.	
Larned.....		07	55.74		03	52.94	G. S.	Do.
La Crosse.....		35	42.96		16	10.33	C. & G. S.	
Last Chance.....		03	40.85		36	12.94	G. S.	Do.
Orwell.....		01	25.08		48	16.96	do	Do.
Pawnee.....		18	05.09		01	25.25	do	Do.
Quarry.....		15	19.81		25	18.54	do	Do.
SE. corner sec. 22, T. 21, R. 22.....		12	13.49		42	58.18	do	Do.
SE. corner sec. 15, T. 22, R. 16.....		07	49.36		03	27.13	do	Do.
SE. corner sec. 29, T. 23, R. 21.....		01	42.99		38	30.01	do	Do.
SE. corner sec. 25, T. 23, R. 23.....		01	16.87		47	17.96	do	Do.
SW. corner sec. 14, T. 23, R. 21.....		03	27.33		36	17.90	do	Do.
NW. corner sec. 19, T. 20, R. 15.....		18	15.26		01	53.60	do	Do.
NW. corner sec. 17, T. 22, R. 20.....		08	43.37		33	02.88	do	Do.
NW. corner sec. 5, T. 21, R. 19.....		15	42.32		25	26.48	do	Do.
NW. corner sec. 30, T. 22, R. 17.....		06	55.99		14	22.27	do	Do.
NW. corner sec. 6, T. 21, R. 17.....		15	38.22		14	01.82	do	Do.
	38°-39°			101°-102°				
Coyote.....	38	01	36.35	101	02	05.96	do	Do.
Lakin.....		00	38.35		14	06.41	do	Do.
NE. corner sec. 35, T. 22, R. 36.....		00	58.76		13	46.56	do	Do.
NW. corner sec. 27, T. 23, R. 34.....		01	53.62		02	47.72	do	Do.
	37°-38°			94°-95°				
Fort Scott:								
Standpipe.....	37	49	54.08	94	42	58.13	do	Bull. 49.
Spire on cupola of Central School.....		50	17.28		42	28.19	do	Do.
Spire of Congregational church.....		50	15.20		42	26.91	do	Do.
Flagstaff in national cemetery.....		49	21.14		41	33.04	do	Do.
Astronomical pier.....		50	25.76		42	26.75	do	Do.
SE. corner sec. 31, T. 25 S., R. 25 E., Bourbon County.		49	13.79		41	42.71	do	Do.

KANSAS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	37°-38°	94°-95°		
	° ' "	° ' "		
¼ sec. corner S. side sec. 31, T. 25 S., R. 25 E., Bourbon County.	37 49 13.73	94 42 15.84	G. S.	Bull. 49.
SW. corner T. 25 S., R. 25 E., Bourbon County.	49 13.75	42 48.78	do	Do.
Oswego:	37°-38°	95°-96°		
Spire Baptist church	37 10 09.45	95 06 22.16	do	Do.
Spire of court-house	09 58.93	06 24.08	do	Do.
Spire Methodist church	10 13.24	06 32.11	do	Do.
Spire schoolhouse	10 09.00	06 48.64	do	Do.
Labette County astronomical pier ..	09 59.81	06 24.66	do	Do.
Engine house	09 58.80	06 28.66	do	Do.
NW. corner T. 30 S., R. 21 E., Labette County.	12 33.38	09 26.37	do	Do.
SW. corner T. 33 S., R. 21 E., Labette County.	11 41.00	09 26.31	do	Do.
Elk Falls:	37°-38°	96°-97°		
Spire Methodist church	37 22 19.87	96 11 22.79	do	Do.
Astronomical pier	22 03.64	11 14.46	do	Do.
¼ sec. corner S. sec. 10, T. 31 S., R. 11 E., Elk County.	21 33.82	11 23.45	do	Do.
SE. corner T. 30 S., R. 11 E., Elk County	23 18.08	08 32.13	do	Do.
SE. corner sec. 10, T. 31 S., R. 11 E., Elk County.	21 33.89	10 49.67	do	Do.
SW. corner sec. 10, T. 31 S., R. 11 E., Elk County.	21 33.83	11 55.21	do	Do.
	37°-38°	99°-100°		
First View	37 59 06.27	99 50 00.11	do	Bull. 122.
Meridian	51 12.71	59 54.26	do	Do.
Purdyville	56 30.51	57 14.45	do	Do.
Spearville (astronomic pier)	59 06.34	45 10.05	do	Bull. 70.
Wright	47 44.38	51 43.91	do	Bull. 122.
SW. corner sec. 8, T. 26, R. 23	47 34.78	52 06.17	do	Do.
SE. corner sec. 21, T. 24, R. 24	56 29.98	57 14.34	do	Do.
SE. corner sec. 3, T. 24, R. 23	59 06.21	49 30.70	do	Do.
NE. corner sec. 29, T. 25, R. 22	51 15.57	45 06.54	do	Do.
N. ¼ corner sec. 30, T. 25, R. 24	51 14.31	52 57.20	do	Do.
	37°-38°	100°-101°		
Bullord	37 52 33.13	100 52 48.00	do	Do.
Cimarron	49 25.42	19 39.01	do	Do.
Standpipe	49 00.32	20 48.05	do	Do.
Schoolhouse	48 31.02	20 40.80	do	Do.
Desolation	46 17.35	41 27.65	do	Do.
Dodge	46 35.40	02 33.52	do	Do.
Garden City:				
North schoolhouse	58 19.70	52 23.70	do	Do.
South schoolhouse	57 39.18	52 14.77	do	Do.
Standpipe	57 50.35	52 41.89	do	Do.
Grandview	40 48.17	14 38.68	do	Do.
Schoolhouse	51 21.97	20 07.73	do	Do.
Ina	43 53.57	28 27.30	do	Do.
Ingalls	51 01.57	28 03.64	do	Do.
Mansfield	58 23.46	45 28.05	do	Do.
Marble	51 23.70	16 52.41	do	Do.
Pretty Prairie schoolhouse	50 26.24	15 47.05	do	Do.
Pierceville	53 23.74	38 07.09	do	Do.
Schoolhouse	53 01.31	40 19.97	do	Do.
Schoolhouse, 4 miles east of Mansfield.	56 11.52	41 58.42	do	Do.
Snyder	51 51.54	06 58.89	do	Do.
S. ¼ corner sec. 23, T. 27, R. 27	40 42.46	14 26.80	do	Do.
SE. corner sec. 36, T. 26, R. 31	44 03.73	39 10.82	do	Do.
SE. corner sec. 27, T. 25, R. 27	50 27.35	15 45.94	do	Do.
SW. corner sec. 19, T. 25, R. 27	51 20.61	20 09.49	do	Do.
SW. corner sec. 31, T. 25, R. 27	49 36.18	20 09.60	do	Do.
SW. corner sec. 22, T. 25, R. 27	51 20.10	16 52.56	do	Do.
NW. corner sec. 8, T. 25, R. 30	54 01.44	38 42.51	do	Do.
NW. corner sec. 6, T. 27, R. 30	44 03.73	39 10.82	do	Do.
N. ¼ corner sec. 30, T. 25, R. 32	51 29.25	52 23.63	do	Do.
N. ¼ corner sec. 3, T. 27, R. 29	44 11.57	28 40.47	do	Do.
NE. corner sec. 22, T. 26, R. 25	46 46.72	01 54.87	do	Do.
NW. corner sec. 19, T. 25, R. 25	52 09.59	06 59.15	do	Do.
NE. corner sec. 18, T. 24, R. 31	58 25.98	45 17.15	do	Do.
E. ¼ corner sec. 26, T. 25, R. 29	50 56.11	27 49.80	do	Do.
	37°-38°	101°-102°		
Ada	37 54 58.57	101 02 23.76	do	Do.
Basin	47 48.35	23 38.21	do	Do.
Deerfield schoolhouse	58 54.76	08 06.13	do	Do.
Hartland	55 17.46	22 32.83	do	Do.
Schoolhouse	53 21.06	22 03.49	do	Do.
Hummock	53 05.37	13 56.65	do	Do.

KANSAS—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	37°-38°	101°-102°		
	° ' "	° ' "		
Lakin schoolhouse.....	37 56 30.75	101 15 27.00	G. S.....	Bull. 122.
NW. corner sec. 11, T. 25, R. 36.....	54 00.98	14 53.67	do.....	Do.
NE. corner sec. 15, T. 24, R. 34.....	58 25.84	01 43.08	do.....	Do.
NW. corner sec. 15, T. 24, R. 34.....	58 25.27	02 49.03	do.....	Do.
W. $\frac{1}{4}$ corner sec. 34, T. 24, R. 37.....	55 17.81	22 32.94	do.....	Do.

MONTANA.

	48°-49°	104°-105°		
	° ' "	° ' "		
Big Horn.....	48 06 26.66	104 23 40.17	Mo. R. C.....	Rept. '91.
Big Muddy.....	09 47.47	34 02.50	do.....	Do.
Boulder.....	04 35.98	31 44.79	do.....	Rept. '94.
Box Elder.....	10 33.79	48 22.05	do.....	Rept. '91.
Devil's Elbow.....	06 08.14	44 40.85	do.....	Do.
Lanark.....	06 16.91	13 52.58	do.....	Do.
Montana.....	01 47.75	03 08.55	do.....	Do.
Mortar Stone.....	04 04.97	57 13.97	do.....	Do.
St. Ange.....	02 06.68	18 58.33	do.....	Do.
	48°-49°	105°-106°		
	° ' "	° ' "		
Deer Tail.....	48 07 35.92	105 04 11.31	do.....	Do.
Elk River.....	00 25.69	46 55.42	do.....	Do.
Hopkins.....	02 08.68	38 43.35	do.....	Do.
Macon.....	08 19.77	29 42.52	do.....	Do.
Oswego.....	04 22.75	51 26.01	do.....	Do.
Poplar.....	08 59.28	14 09.51	do.....	Do.
Red Water.....	02 37.76	09 02.55	do.....	Do.
Santee.....	03 27.58	55 59.62	do.....	Do.
Spread Eagle.....	03 36.87	27 32.59	do.....	Do.
Wolf Point.....	06 26.05	41 55.68	do.....	Do.
	48°-49°	106°-107°		
	° ' "	° ' "		
Galpin.....	48 05 17.67	106 26 06.81	do.....	Do.
Knityre.....	03 33.93	09 22.09	do.....	Do.
Lennox.....	04 11.32	00 58.51	do.....	Do.
Milk River.....	01 48.31	18 48.58	do.....	Do.
Nassau.....	05 36.59	18 22.52	do.....	Do.
Peck.....	00 11.09	32 38.43	do.....	Do.
	48°-49°	109°-110°		
	° ' "	° ' "		
Bear Paw.....	48 09 00.00	109 38 58.00	G. S.....	Bull. 122.
	48°-49°	110°-111°		
	° ' "	° ' "		
Coal banks.....	48 02 03.88	110 15 33.74	Mo. R. C.....	Rept. '91.
Old.....	03 26.97	09 39.62	do.....	Do.
Recess.....	00 49.09	20 01.91	do.....	Do.
Sandy.....	00 38.09	04 48.12	do.....	Do.
Shanks.....	00 08.83	14 22.37	do.....	Do.
	48°-49°	111°-112°		
	° ' "	° ' "		
Sweet Grass.....	48 50 52.60	111 22 21.00	G. S.....	Bull. 122.
	47°-48°	104°-105°		
	° ' "	° ' "		
Cut-off.....	47 59 47.20	104 09 54.16	Mo. R. C.....	Rept. '91.
Ferry.....	58 33.35	04 24.47	do.....	Do.
	47°-48°	105°-106°		
	° ' "	° ' "		
Amelia Poe.....	47 59 00.40	105 58 22.00	do.....	Do.
	47°-48°	106°-107°		
	° ' "	° ' "		
Bone Bluffs.....	47 59 41.26	106 09 55.95	do.....	Do.
Double Hill.....	49 41.74	41 27.69	do.....	Do.
Dry Fork.....	56 41.03	22 37.37	do.....	Do.
Featherland.....	42 33.32	50 33.24	do.....	Rept. '94.
Five Pines.....	46 52.24	52 18.35	do.....	Rept. '91.
Hell Creek.....	39 47.17	53 31.71	do.....	Do.
Juniper.....	53 44.55	34 18.87	do.....	Do.
Last Pine.....	50 53.27	29 17.43	do.....	Do.
Norris.....	44 37.67	40 43.43	do.....	Rept. '94.
	47°-48°	107°-108°		
	° ' "	° ' "		
Above.....	47 32 03.84	107 54 20.64	do.....	Rept. '91.
Ball Rock.....	39 29.88	30 57.03	do.....	Do.
Below.....	30 31.59	50 14.12	do.....	Do.
Cowboy.....	28 31.05	55 47.75	do.....	Do.
Cut-off.....	34 08.71	54 33.34	do.....	Do.
Dogtown.....	36 20.51	32 31.11	do.....	Do.
East base.....	38 18.80	39 18.11	do.....	Do.
Elk.....	36 16.75	44 01.10	do.....	Do.
Forgey.....	39 16.00	39 41.14	do.....	Do.
Gibson.....	38 11.41	12 31.92	do.....	Do.
Grizzly.....	41 58.38	00 13.20	do.....	Do.

MONTANA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference
	47°-48°			107°-108°				
	°	'	"	°	'	"		
Horn	47	35	59.26	107	40	47.11	Mo. R. C.	Rept. '91.
Hornet		32	38.22		50	38.27	do	Do.
Lake		35	03.16		56	40.76	do	Do.
Little Snow		38	34.53		03	20.67	do	Do.
Mussel Shell		29	50.20		55	29.51	do	Rept. '86.
Do		29	20.98		52	02.33	do	Do.
Do		26	20.74		54	16.60	do	Rept. '94.
Mussel Shell Cowboy		28	16.80		55	46.48	do	Rept. '86.
Nest		30	44.69		48	31.92	do	Rept. '91.
Pike		33	23.66		57	46.33	do	Do.
Raid		30	04.46		55	30.78	do	Do.
Rock Peak		43	18.56		24	39.82	do	Do.
Seven Black Feet		38	36.12		23	05.48	do	Do.
Three Canyon		42	24.37		11	22.41	do	Do.
Track		33	08.75		43	45.43	do	Do.
Tail		36	59.04		37	19.34	do	Rept. '94.
West base		37	48.39		41	32.56	do	Rept. '91.
Wilson		34	03.26		47	01.22	do	Do.
Williams		29	35.23		52	03.60	do	Do.
	47°-48°			108°-109°				
	°	'	"	°	'	"		
Across	47	35	01.82	108	05	55.67	do	Do.
Armel		36	25.62		38	57.90	do	Do.
Autumn		36	28.04		24	43.91	do	Do.
Bend		43	12.03		54	59.54	do	Do.
Brevier		36	01.95		36	05.20	do	Do.
Buffalo		38	56.75		40	38.60	do	Do.
Calf Island		37	59.82		44	03.36	do	Do.
Carroll, astronomic monument		34	48.00		24	00.00	Engr. Corps.	Rept. '76.
Carroll		33	33.51		21	15.46	Mo. R. C.	Rept. '91.
Cow Island		45	37.23		57	32.53	do	Do.
Creek		37	30.45		29	27.15	do	Do.
Crystal		42	00.81		52	22.07	do	Do.
Fortress		44	34.39		51	10.03	do	Do.
Frost		35	42.61		01	32.91	do	Do.
Grand Island		42	09.59		46	57.53	do	Do.
Harriet		38	08.92		36	04.82	do	Do.
Hawley		37	19.61		05	52.90	do	Do.
Kammuck		35	35.00		10	04.69	do	Do.
Landing		46	18.05		54	36.27	do	Do.
Line		33	51.19		07	46.80	do	Do.
Lopp		34	40.37		25	48.83	do	Do.
Plain		35	47.63		16	04.09	do	Do.
Quarter		40	03.27		48	54.73	do	Do.
Rocky Point		35	05.31		28	12.45	do	Do.
Ryan		35	30.56		20	19.07	do	Do.
Ryan Island		34	09.05		16	23.59	do	Do.
Sage		33	51.08		12	31.44	do	Do.
Slide		33	52.69		00	48.98	do	Do.
Snake Point		49	15.20		58	36.32	do	Do.
Willow		40	24.04		44	17.96	do	Do.
	47°-48°			109°-110°				
	°	'	"	°	'	"		
Arrow	47	41	16.56	109	48	25.54	do	Do.
Bear		44	33.20		26	43.77	do	Do.
Bird		45	47.33		08	35.83	do	Do.
Chimney		46	33.61		15	42.08	do	Do.
Camp Lewis		03	47.00		26	30.00	Engr. Corps.	Rept. '76.
Council		46	25.29		35	22.22	Mo. R. C.	Rept. '91.
Dauphin		43	44.99		21	54.71	do	Do.
Gallatin		42	35.84		27	45.47	do	Do.
Holmes		43	35.91		31	39.21	do	Do.
Iron City		45	22.32		31	02.96	do	Do.
Judith		13	07.90		13	15.60	G. S.	Bull. 122.
Do		42	32.35		37	48.91	Mo. R. C.	Rept. '91.
Lone Pine		47	45.88		19	42.25	do	Do.
Pablos		45	41.21		51	01.26	do	Do.
Pinnacles		48	14.73		57	00.84	do	Do.
Pines		41	14.31		42	49.03	do	Do.
Plateau		43	06.51		44	54.96	do	Do.
Rapids		46	06.09		22	48.14	do	Do.
Rondeau		44	04.21		54	17.48	do	Do.
Spruce		46	19.96		02	38.70	do	Do.
Sturgeon		48	43.10		04	14.66	do	Do.
Tip Top		44	02.31		49	46.99	do	Do.
Valley		44	48.93		42	20.15	do	Do.
Wall		46	32.02		59	10.46	do	Do.
Windsor		48	32.66		11	49.10	do	Do.
	47°-48°			110°-111°				
	°	'	"	°	'	"		
Arrow	47	25	40.70	110	31	35.90	G. S.	Bull. 122.
Benton		48	46.57		41	58.56	Mo. R. C.	Rept. '91.

MONTANA—Continued.

Name.	Latitude.			Longitude.			Authority.	Reference.
	47°-48°			110°-111°				
Benton—Continued.	°	'	"	°	'	"		
Flagstaff, Fort Benton	47	48	50.00	110	39	48.00	Mo. R. C.	Rept. '86.
Hub		50	07.77		39	54.78	do	Do.
Black Bluff		54	14.75		26	45.31	do	Do.
Brule		51	12.81		30	24.63	do	Rept. '91.
Burned		57	21.22		03	37.90	do	Do.
Castle		53	35.28		02	53.16	do	Do.
Cherry		43	13.38		47	17.84	do	Do.
Citadel		50	32.65		02	30.41	do	Do.
Crocon		52	33.58		34	41.82	do	Do.
East base		50	40.25		40	04.27	do	Do.
Fort Benton		49	38.00		39	48.00	Engr. Corps.	Rept. '76.
Flagstaff		49	03.97		39	49.88	Mo. R. C.	Rept. '91.
Harvey		50	36.73		33	53.53	do	Do.
Highwood		39	23.28		52	42.02	do	Do.
Hub		50	22.02		39	56.05	do	Do.
Iron		59	10.69		08	35.41	do	Do.
Kipp		52	03.18		05	35.18	do	Do.
Labarge		49	22.72		04	55.60	do	Do.
Marias		56	22.17		29	10.45	do	Do.
Mound		58	47.44		17	50.70	do	Do.
Ridge		59	24.12		26	04.38	do	Do.
Shanks		59	54.58		14	21.10	do	Rept. '86.
Shonkin		49	46.05		36	51.86	do	Rept. '91.
Sheperd		34	56.62		56	19.23	do	Do.
Sidney		45	54.63		58	38.04	do	Do.
Tele		54	23.77		32	07.22	do	Do.
Teton		52	13.47		43	04.88	do	Do.
Three Islands		56	39.54		22	33.62	do	Do.
Tunis		48	21.61		49	09.03	do	Do.
Wellman		54	40.87		05	38.27	do	Do.
West base		50	11.78		42	22.60	do	Do.
White Cliffs		55	49.34		05	53.22	do	Do.
	47°-48°			111°-112°				
Antelope	47	26	31.90	111	25	39.49	do	Do.
Belt		31	56.14		01	44.37	do	Do.
Big Bend		21	56.84		16	47.17	do	Do.
Bromedy		32	02.94		08	14.02	do	Do.
Cascade		16	57.73		42	35.55	do	Do.
Craig		08	08.17		57	39.28	do	Do.
Divide		18	18.23		31	35.45	do	Do.
Earley		35	24.18		06	59.64	do	Do.
Epler		26	27.04		21	28.03	do	Do.
Fort Shaw		30	33.06		48	19.50	Engr. Corps.	Rept. '76.
Great Falls		29	44.61		15	01.52	Mo. R. C.	Rept. '91.
Hardy		13	01.29		48	39.11	do	Do.
Henry		30	35.42		11	24.85	do	Do.
Muddy Creek		21	32.05		35	28.17	do	Do.
North Great Falls		31	49.87		15	26.23	do	Do.
Portage		39	16.64		05	17.12	do	Do.
Porter		33	51.22		10	36.12	do	Do.
Sand Conlee		25	53.99		16	35.23	do	Do.
Sheep Creek		10	09.45		42	23.21	do	Do.
St. Clair		14	45.84		37	02.99	do	Do.
Stickney		06	53.30		51	11.28	do	Do.
Shaw		26	29.70		44	56.70	G. S.	Bull. 122.
Sugarloaf		09	53.40		54	14.73	Mo. R. C.	Rept. '91.
Sun River		28	44.79		21	13.92	do	Do.
Transfer		31	23.80		19	48.32	do	Do.
Ulm		26	23.11		31	04.52	do	Do.
Wagner		04	54.28		55	41.24	do	Do.
Wilson		24	03.17		24	39.61	do	Do.
	47°-48°			112°-113°				
Keep Cool	47	07	08.20	112	44	21.20	G. S.	Bull. 122.
Rock Creek		03	28.37		00	32.99	Mo. R. C.	Rept. '91.
Rocky		48	53.50		48	03.10	G. S.	Bull. 122.
Wolf Creek		00	38.41		03	34.61	Mo. R. C.	Rept. '91.
	47°-48°			113°-114°				
McDonald	47	23	11.00	113	55	18.00	G. S.	Bull. 122.
	46°-47°			105°-106°				
Fort Keogh	46	23	11.65	105	56	53.08	Engr. Corps.	Rept. '79.
	46°-47°			107°-108°				
East base (Custer Z. station)	46	07	55.70	107	31	00.30	G. S.	Bull. 122.
Terry		10	36.20		36	12.00	do	Do.
West base		06	10.60		33	18.10	do	Do.
	46°-47°			109°-110°				
Big Snowy	46	45	12.30	109	18	48.80	do	Do.
	46°-47°			110°-111°				
Brewer Springs	46	32	50.00	110	55	40.00	Engr. Corps.	Rept. '76.
Crazy		01	13.10		16	36.20	G. S.	Bull. 122.

MONTANA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	46°-47°	110°-111°		
	° ' "	° ' "		
Elk	46 27 17.60	110 45 12.30	G. S.	Bull. 122.
Moss Agate Springs	23 40.00	53 30.00	Engr. Corps ..	Rept. '76.
Neihart	58 15.10	36 22.50	G. S.	Bull. 122.
	46°-47°	111°-112°		
American	46 50 00.68	111 53 07.21	Mo. R. C.	Rept. '91.
Beattie	00 30.20	27 08.39	do	Do.
Beaver Creek	29 06.93	34 59.09	do	Do.
B. T. Mountain	53 53.48	59 03.10	do	Do.
Blackwell	36 46.75	35 45.27	do	Do.
Boulder	17 46.30	54 14.00	do	Do.
Bridge	20 24.18	32 05.67	do	Do.
Camp Baker	40 44.00	11 00.00	Engr. Corps ..	Rept. '76.
Canyon Ferry	38 43.09	44 22.38	Mo. R. C.	Rept. '91.
Carolus	05 41.54	21 58.72	do	Do.
Confederate	30 13.77	31 09.79	do	Do.
Degau	34 43.24	40 19.41	do	Do.
Deep Creek	18 38.94	26 28.25	do	Do.
Dougherty	09 55.63	28 40.36	do	Do.
Duck Creek	27 18.96	28 06.48	do	Do.
El Dorado	44 31.80	48 44.29	do	Do.
Toston	10 06.61	23 48.50	do	Do.
Fuller	41 10.76	45 20.00	do	Do.
Geary	33 12.86	32 12.82	do	Do.
Hilger	46 10.07	55 48.43	do	Do.
Hossfeld	15 42.71	30 19.67	do	Do.
Howard	12 42.93	30 34.69	do	Do.
Junction	01 03.34	30 31.21	G. S.	Bull. 122.
Lone Bush	08 52.28	22 26.53	Mo. R. C.	Rept. '91.
Magpie	02 59.68	22 22.11	do	Do.
Marks	24 21.71	26 35.96	do	Do.
Maxwell	40 25.96	40 00.33	do	Do.
Mitler	59 45.10	55 42.40	do	Do.
Ox Bow	57 33.39	59 28.12	do	Do.
Ox Bow (Moore Mountain)	55 54.80	44 01.10	do	Do.
Painted Rock	07 49.71	24 57.99	do	Do.
Pinnacle	05 36.80	24 12.72	do	Do.
Prickly Pear	43 11.57	53 26.59	do	Do.
Reed	25 58.97	33 54.40	do	Do.
Reeves	13 36.79	25 37.74	do	Do.
Sawyer	02 51.66	25 44.60	do	Do.
Squires	31 36.95	36 45.88	do	Do.
Stubbs	39 38.06	51 04.31	do	Do.
Willow Creek	56 23.28	53 00.14	do	Do.
	46°-47°	112°-113°		
Mitchell	46 58 56.00	112 16 54.00	G. S.	Bull. 122.
Powell	21 07.30	58 48.60	do	Do.
	45°-46°	107°-108°		
Abbott (Abbott's Urn)	45 40 48.80	107 22 59.50	do	Do.
Custer	34 30.40	16 50.10	do	Do.
Far West	36 43.50	47 04.30	do	Do.
Little Horn	03 26.00	25 49.70	do	Do.
Mesa	49 37.50	50 50.30	do	Do.
Pine Ridge	59 14.60	39 34.70	do	Do.
Reno	11 08.30	26 42.70	do	Do.
Red Bluff	02 16.90	11 33.30	do	Do.
Rosebud	20 41.20	11 32.40	do	Do.
Rotten Grass	21 06.60	33 51.70	do	Do.
Ryan	54 22.10	27 07.00	do	Do.
	45°-46°	108°-109°		
Absaroka	45 42 39.70	108 08 56.70	do	Do.
Billings	42 59.30	27 32.20	do	Do.
Boundary	31 13.70	35 48.50	do	Do.
Canyon	50 03.20	47 40.90	do	Do.
Mauvaise Terre	33 41.90	19 41.10	do	Do.
	45°-46°	109°-110°		
Granite	45 09 56.00	109 48 22.00	do	Do.
Shane	30 45.30	08 11.50	do	Do.
Stillwater	35 28.00	34 16.20	do	Do.
White Beaver	50 05.20	18 01.80	do	Do.
Wilson	51 48.10	39 10.10	do	Do.
	45°-46°	110°-111°		
Bozeman, Station X	45 41 15.30	110 59 19.20	Wheeler	Do.
Bridger Mountain	47 36.80	56 15.60	G. S.	Do.
Electric Peak	00 27.04	50 15.05	do	Do.
Emigrant Peak	15 54.13	42 25.35	do	Do.
Fort Ellis, flagstaff	40 13.45	58 30.97	Wheeler	Do.
Grassy Knoll	41 42.64	59 00.18	G. S.	Do.
Haystack	11 55.89	13 17.58	do	Do.

MONTANA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	45°-46° ° ' "	110°-111° ° ' "		
Livingston.....	25 35 30.60	110 27 33.60	G. S.....	Bull. 122.
Pass.....	30 39.80	01 08.40	do.....	Do.
	45°-46° ° ' "	111°-112° ° ' "		
Blackmore, mountain.....	45 26 48.02	111 00 13.40	do.....	Do.
Bozeman:				
Astronomical station.....	40 51.92	02 36.64	do.....	Do.
North base.....	42 45.29	06 26.08	do.....	Do.
South base.....	39 09.64	04 02.09	do.....	Do.
Station Y.....	40 00.52	01 37.08	Wheeler.....	Do.
Campbell.....	56 55.82	29 09.18	Mo. R. C.....	Rept. '91.
Cedar Knoll.....	39 03.61	13 36.46	G. S.....	Bull. 122.
Cedar Hill.....	56 43.20	27 44.22	Mo. R. C.....	Rept. '91.
Clarke.....	59 58.75	23 05.51	do.....	Do.
Gallatin.....	22 13.27	21 56.86	G. S.....	Bull. 122.
Do.....	56 07.65	28 43.28	Mo. R. C.....	Rept. '91.
Huntley.....	57 50.20	25 42.38	do.....	Do.
North base.....	55 43.36	30 04.84	do.....	Do.
Point 5.....	51 24.87	09 12.76	G. S.....	Bull. 122.
South base.....	54 58.35	29 43.63	Mo. R. C.....	Rept. '91.
Spring.....	57 57.52	28 10.92	do.....	Do.
	45°-46° ° ' "	112°-113° ° ' "		
Jefferson.....	45 36 49.38	112 00 29.62	G. S.....	Bull. 122.
Tweedy.....	28 57.00	57 56.60	do.....	Do.
	44°-45° ° ' "	111°-112° ° ' "		
Hilgard.....	44 55 08.17	111 27 32.99	do.....	Do.
Sawtelle.....	33 56.05	26 40.33	do.....	Do.

WYOMING.

	44°-45° ° ' "	107°-108° ° ' "		
Cloud Peak.....	44 23 00.20	107 10 23.00	G. S.....	Bull. 122.
	44°-45° ° ' "	109°-110° ° ' "		
Index Peak.....	44 58 36.60	109 53 04.00	Hayden.....	Rept. '77.
Do.....	58 41.88	52 53.07	G. S.....	Bull. 122.
	44°-45° ° ' "	110°-111° ° ' "		
Sheridan.....	44 16 06.02	110 31 44.81	do.....	Do.
Washburne.....	47 58.95	26 01.85	do.....	Do.
	43°-44° ° ' "	104°-105° ° ' "		
Northwest corner of Nebraska.....	43 00 04.20	104 02 49.60	do.....	
	43°-44° ° ' "	106°-107° ° ' "		
Fort McKinney.....	43 47 05.60	106 15 12.75	Engr. Corps..	Rept. '78.
	43°-44° ° ' "	108°-109° ° ' "		
Alamocita Peak.....	43 11 56.00	108 28 17.00	Wheeler.....	Rept. '79.
	43°-44° ° ' "	109°-110° ° ' "		
Fremont Peak.....	43 07 28.50	109 37 17.30	Hayden.....	Rept. '77.
Washakie Needle.....	44 51.70	12 19.70	do.....	Do.
Yount Peak.....	59 02.76	51 58.28	G. S.....	Bull. 122.
	43°-44° ° ' "	110°-111° ° ' "		
Gros Ventre Peak.....	43 16 54.40	110 14 00.50	Hayden.....	Rept. '77.
Hayden Mountain.....	44 29.60	48 22.80	do.....	Do.
Hoback Peak.....	05 04.20	34 27.30	do.....	Do.
	42°-43° ° ' "	104°-105° ° ' "		
Fort Laramie flagstaff.....	42 12 01.31	104 33 27.27	Engr. Corps..	Rept. '78.
	42°-43° ° ' "	105°-106° ° ' "		
Fort Fetterman.....	42 50 26.26	105 29 12.60	L. S.....	Final Rept.
Laramie Peak.....	16 00.00	26 50.00	Hayden.....	Rept. '77.
	42°-43° ° ' "	107°-108° ° ' "		
Rattlesnake Peak.....	42 10 01.70	107 03 35.90	do.....	Do.
Seminole Peak.....	15 23.50	14 30.00	do.....	Do.
Whiskey Peak.....	18 36.70	34 34.50	do.....	Do.
	42°-43° ° ' "	108°-109° ° ' "		
Yellow Butte.....	42 16 05.30	108 43 18.00	do.....	Do.
	42°-43° ° ' "	109°-110° ° ' "		
Atlantic Peak.....	42 36 59.30	109 00 16.50	do.....	Do.
Mount Bonneville.....	51 35.10	20 48.20	do.....	Do.
New Fork Peak.....	59 58.30	35 36.90	do.....	Do.
West Atlantic Peak.....	37 17.20	01 07.30	do.....	Do.
Wind River Peak.....	42 29.70	09 54.50	do.....	Do.

WYOMING—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43° ° / "	110°-111° ° / "		
Wyoming Peak	42 36 14.90	110 37 39.70	Hayden	Rept. '77.
Cheyenne:	41°-42°	104°-105°		
Astronomical station	41 07 46.62	104 48 51.30	Wheeler	Rept. '73.
Railroad depot	07 57.77	49 11.65	do	Rept. '79.
Russell, Fort D. A., flagstaff	08 38.83	50 24.47	do	Do.
	41°-42°	105°-106°		
Ames	41 07 54.55	105 23 44.32	G. S.	Bull. 122.
Antelope	22 10.06	34 23.14	do	Do.
Astronomical pier	18 51.80	35 33.60	do	Do.
County road	21 02.92	42 16.45	do	Do.
Dale	10 54.33	27 39.88	do	Do.
Fort Sanders flagstaff	17 26.89	34 59.56	Wheeler	Rept. '73.
Jelm	05 52.06	58 28.70	G. S.	Bull. 122.
Laramie	18 51.80	35 33.60	Wheeler	Rept. '72.
Lindsey	06 17.33	38 14.08	G. S.	Bull. 122.
Quartzite	25 34.91	27 27.53	do	Do.
Rock Creek station, river bank of Rock Creek.	50 25.72	52 24.60	Engr. Corps ..	Rept. '78.
Sherman	07 50.00	23 33.15	C. & G. S.	Rept. '84.
Soda	20 10.28	35 02.97	G. S.	Bull. 122.
University	18 47.09	34 53.75	do	Do.
	41°-42°	106°-107°		
Fort Fred Steele flagstaff	41 46 50.63	106 56 54.27	Wheeler	Final Rept.
Medicine Bow	21 39.40	18 54.20	G. S.	Bull. 122.
Mount Steele	50 14.80	59 59.60	Hayden	Rept. '77.
	41°-42°	107°-108°		
Cherokee Peak	41 48 54.60	107 19 42.80	do	Do.
East end of Rawlins base line	25 23.40	18 15.00	do	Do.
Rawlins Peak	48 14.90	16 14.90	do	Do.
Separation Peak	38 14.40	23 53.50	do	Do.
West end of Rawlins base line	46 16.50	21 30.60	do	Do.
	41°-42°	108°-109°		
Black Butte	41 33 29.40	108 48 12.70	do	Do.
Essex Mountain	58 22.20	58 20.60	do	Do.
	41°-42°	109°-110°		
Green River, astronomical observ- atory.	41 31 38.12	109 28 06.57	Wheeler	Final Rept.
Pilot Butte	38 34.00	21 19.60	Hayden	Rept. '77.
	41°-42°	110°-111°		
Medicine Butte	41 21 06.50	110 54 42.50	do	Do.

COLORADO.

	40°-41° ° / "	102°-103° ° / "		
Julesburg, astronomical station	40 59 07.63	102 21 32.30	Wheeler	Final Rept.
	40°-41°	105°-106°		
Long's Peak	40 15 20.80	105 36 38.20	Hayden	Rept. '76.
	40°-41°	106°-107°		
Park View Peak	40 19 52.20	106 07 53.20	do	Do.
	39°-40°	103°-104°		
Holt	39 02 15.73	103 57 48.43	C. & G. S.	Do.
Hugo	04 27.83	30 20.07	do	Do.
Coulson's house, chimney	07 55.27	27 50.43	do	Do.
Schoolhouse chimney	08 03.59	27 50.35	do	Do.
Section-house chimney	07 52.85	27 27.93	do	Do.
Overland	02 15.04	09 46.75	do	Do.
Subsidiary station	05 46.45	32 01.30	do	Do.
	39°-40°	104°-105°		
Denver, Coast Survey astronomical station.	39 45 21.71	104 59 31.94	do	Rept. '82.
Denver:				
East end of base	45 52.20	47 39.20	Hayden	Rept. '76.
West end of base	46 22.70	54 25.30	do	Do.
Schoolhouse	45 00.70	59 23.40	do	Do.
Derrick station	43 54.80	57 08.90	do	Do.
Divide	04 10.08	30 15.64	C. & G. S.	
Dry Creek station	56 57.00	55 51.80	Hayden	Do.
Holcolm Hills	00 02.96	18 30.86	C. & G. S.	
Hughes, astronomical station	59 24.09	48 58.80	Wheeler	Final Rept.

COLORADO—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	39°-40°	105°-106°		
	° / "	° / "		
Evans, Mount.....	39 35 21.30	105 38 21.90	Hayden.....	Rept. '76.
Georgetown.....	42 36.36	41 27.64	Wheeler.....	Final Rept.
Morrison, Mount.....	40 12.40	12 55.30	Hayden.....	Rept. '76.
Platte Peak.....	15 40.50	05 49.00	do.....	Do.
South Boulder Peak.....	57 15.60	17 42.10	do.....	Do.
Torrey Peak.....	38 37.40	48 01.10	do.....	Do.
	39°-40°	106°-107°		
Ashcroft.....	39 02 28.60	106 46 43.40	G. S.....	Bull. 122.
Bien's Station, 12.....	08 36.70	52 22.40	do.....	Do.
Bien's Station, 47.....	13 17.40	44 10.50	do.....	Do.
Castle Peak.....	00 29.80	51 44.00	do.....	Do.
Highland.....	07 40.20	52 39.90	do.....	Do.
Holy Cross Mountain.....	28 05.20	28 39.10	Hayden.....	Rept. '76.
La Plata Mountain.....	01 50.30	28 09.20	do.....	Do.
Lincoln, Mount.....	21 09.10	06 26.80	do.....	Do.
Powell, Mount.....	45 41.10	20 10.20	do.....	Do.
	39°-40°	107°-108°		
Chair Mount.....	39 03 24.00	107 17 00.60	G. S.....	Bull. 122.
Leon Peak.....	04 51.00	50 24.70	Hayden.....	Rept. '76.
North Mam.....	23 16.60	51 43.80	do.....	Do.
Snow Mass.....	07 02.70	04 03.20	G. S.....	Bull. 122.
Sopris Peak:				
North end.....	15 52.90	10 21.10	Hayden.....	Rept. '76.
Middle summit.....	15 36.20	09 57.40	G. S.....	Bull. 122.
Treasury.....	00 46.20	06 00.70	do.....	Do.
	38°-39°	102°-103°		
Eureka.....	38 58 34.79	102 51 17.19	C. & G. S.....	
First View.....	47 37.47	32 26.54	do.....	
Section-house chimney.....	48 57.02	31 58.53	do.....	
Kit Carson.....	42 02.30	51 06.24	do.....	
Landsman.....	56 47.11	34 46.24	do.....	
	38°-39°	103°-104°		
Adobe.....	38 40 35.56	103 32 47.47	do.....	
Arroya.....	48 04.70	10 26.74	do.....	
Section-house chimney.....	51 15.33	07 35.32	do.....	
Cramer Gulch.....	35 30.87	55 25.46	do.....	
Square Bluffs.....	51 03.08	49 14.73	do.....	
	38°-39°	104°-105°		
Bear Creek.....	38 48 51.97	104 52 52.02	do.....	
Besores ranch, chimney.....	59 10.76	28 21.04	do.....	
Big Springs.....	45 01.22	14 40.77	do.....	
Colorado City, schoolhouse, south-east chimney.....	50 43.76	51 09.31	do.....	Rept. '82.
Colorado Springs.....	49 58.02	49 06.14	do.....	Do.
United States Coast Survey station.....	50 00.30	49 07.60	do.....	Do.
Public school flagstaff.....	50 06.21	48 58.63	do.....	Do.
Corps of Engineers, astronomical station.....	49 38.69	49 16.47	do.....	Do.
College cupola.....	50 47.92	49 01.66	do.....	Do.
Corral Bluffs.....	52 06.45	35 05.34	do.....	Do.
El Paso:				
West base (1879).....	58 37.96	34 50.31	do.....	
East base (1879), astronomical station.....	57 17.10	27 12.98	do.....	
Glen Eyre.....	53 54.14	53 58.95	do.....	
Munson and Hamblin's barn.....	57 28.92	27 09.04	do.....	
Pemington, house chimney.....	58 42.62	41 57.72	do.....	
South Pueblo.....	15 42.84	36 57.53	Wheeler.....	
	38°-39°	105°-106°		
Clayton Cone.....	38 12 58.20	105 55 29.30	Hayden.....	Rept. '76.
Hunt Peak.....	23 03.30	50 30.50	do.....	Do.
Labran, astronomical monument.....	23 08.97	06 17.78	Wheeler.....	Do.
Pikes Peak.....	50 21.11	02 08.30	C. & G. S.....	
Rito Alto Peak.....	13 14.20	45 10.10	Hayden.....	Do.
San Luis base:				
South end.....	15 14.00	57 07.00	do.....	Do.
North end.....	19 40.30	59 04.40	do.....	Do.
	38°-39°	106°-107°		
Agency Peak.....	38 16 30.70	106 51 47.60	do.....	Do.
Gunnison, northeast corner Virginia avenue and Wisconsin street.....	32 42.13	55 39.49	do.....	Do.
Harvard Mount.....	55 32.20	19 01.30	do.....	Do.
Hunt Peak.....	25 23.40	13 10.40	Wheeler.....	Final Rept.
Observatory Cone.....	34 40.60	51 36.70	do.....	Do.
Ouray Mount.....	25 26.10	13 15.70	Hayden.....	Rept. '76.
Princeton Mount.....	45 01.30	14 19.20	do.....	Do.
Station 23.....	16 34.60	06 00.60	do.....	Do.

COLORADO—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	38°-39° ° / "	106°-107° ° / "		
Station 24.....	38 19 34.20	106 12 52.90	Hayden.....	Rept. '76.
Station 33.....	01 27.80	55 11.40	do.....	Do.
	38°-39°	107°-108°		
Blaine Peak.....	38 00 14.00	107 47 22.00	Wheeler.....	Final Rept.
Carbon Mountain.....	47 38.60	02 23.90	do.....	Do.
Handie Peak.....	54 46.20	30 05.50	do.....	Do.
Horsefly Mount.....	11 42.50	55 38.60	do.....	Do.
Mears Peak.....	01 50.10	54 23.40	do.....	Do.
Sneffels Mount.....	00 19.00	47 18.70	Hayden.....	Rept. '76.
Uncompahgre Peak.....	04 23.00	27 30.10	do.....	Do.
West Elk Peak.....	43 09.20	11 44.20	do.....	Do.
Wetterhorn.....	03 45.60	30 30.90	Wheeler.....	Final Rept.
	38°-39°	108°-109°		
Grand Mesa.....	38 53 34.00	108 10 23.00	do.....	Do.
	37°-38°	104°-105°		
Fisher Peak.....	37 05 59.60	104 27 31.90	Hayden.....	Rept. '76.
East Spanish Peak.....	23 40.50	54 59.90	do.....	Do.
West Spanish Peak.....	22 37.60	59 24.30	do.....	Do.
Trinidad, United States Coast Survey station.	10 13.80	30 07.50	do.....	Do.
	37°-38°	105°-106°		
Blanca Peak.....	37 34 43.50	105 28 55.40	do.....	Do.
Culebra Peak.....	07 25.10	10 56.30	do.....	Do.
Crestone Peak.....	58 05.30	34 54.00	do.....	Do.
Garland, Fort, flagstaff.....	25 27.33	25 33.73	Wheeler.....	Rept. '79.
	37°-38°	106°-107°		
Banded Peak.....	37 06 21.60	106 37 24.50	Hayden.....	Rept. '76.
Conejos Peak.....	17 24.50	34 02.40	do.....	Do.
Del Norte Peak.....	28 58.00	25 53.00	Wheeler.....	Final Rept.
Del Norte Hill.....	40 13.80	21 25.50	do.....	Do.
Macomb Peak.....	34 25.40	58 43.00	do.....	Do.
Meigs Peak.....	21 01.50	41 38.80	do.....	Do.
San Luis Peak.....	59 16.80	55 39.20	Hayden.....	Rept. '76.
Station 28.....	35 18.10	32 16.40	do.....	Do.
Station 81.....	02 30.60	37 31.60	do.....	Do.
South River Peak.....	34 31.70	58 40.20	do.....	Do.
Summit Peak.....	21 07.30	41 35.40	do.....	Do.
	37°-38°	107°-108°		
Æolus Mount.....	37 37 39.40	107 36 15.40	Wheeler.....	Final Rept.
Bristol Head.....	47 34.50	03 17.90	do.....	Do.
Buffalo Peak.....	36 24.40	29 26.80	do.....	Do.
Canby Mount.....	46 54.60	30 50.00	do.....	Do.
Engineer Mountain.....	41 57.10	48 14.10	do.....	Do.
Glacier Mount.....	50 20.70	59 20.00	do.....	Do.
Pagosa Peak.....	26 43.10	03 47.20	Hayden.....	Rept. '76.
Pole Creek Mountain.....	47 30.50	25 25.70	Wheeler.....	Final Rept.
Red Cloud Peak.....	56 26.70	25 07.80	do.....	Do.
Rio Grande Pyramid.....	40 52.20	23 19.20	Hayden.....	Rept. '76.
Simpson Mount.....	40 53.70	23 11.30	Wheeler.....	Final Rept.
Sultan Mountain.....	47 09.60	42 03.60	do.....	Do.
Wilson Mount.....	50 26.40	59 16.90	Hayden.....	Rept. '76.
	37°-38°	108°-109°		
Dunn Peak.....	37 50 24.20	108 05 37.20	Wheeler.....	Final Rept.
Hesperis Peak.....	26 44.20	05 02.20	Hayden.....	Rept. '76.
Lone Cone.....	53 19.20	15 04.40	do.....	Do.
Ute Peak.....	17 03.00	46 42.50	G. S.....	Bull. 122.

NEW MEXICO.

	36°-37° ° / "	103°-104° ° / "		
Carriso.....	36 09 12.70	103 58 35.90	G. S.....	Bull. 122.
	36°-37°	104°-105°		
Cimarron, astronomical monument.....	36 30 10.01	104 54 59.04	Engr. Corps..	Rept. '76.
Laughlin.....	37 33.20	11 08.00	G. S.....	Bull. 122.
	36°-37°	105°-106°		
Costilla Peak.....	36 50 06.00	105 13 09.40	Hayden.....	Rept. '76.
Ocate.....	05 42.90	03 38.30	G. S.....	Bull. 122.
Taos Peak.....	33 23.00	24 46.00	Wheeler.....	Final Rept.
	36°-37°	106°-107°		
Copper.....	36 01 59.90	106 51 16.80	G. S.....	Bull. 122.
Langley.....	00 28.00	23 03.30	do.....	Do.
Plaza La Nutria.....	42 04.63	23 40.99	Engr. Corps..	Rept. '76.
Santa Clara Mountain.....	00 25.80	22 54.00	Wheeler.....	Final Rept.

NEW MEXICO—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	36°-37° ° / "	107°-108° ° / "		
La Huerfano.....	36 25 34.10	107 50 41.20	G. S.....	Bull. 122
	36°-37°	108°-109°		
San Juan Needle.....	36 41 15.20	108 49 50.40	Hayden.....	Rept. '76.
	35°-36°	104°-105°		
Aguilar.....	35 22 43.10	104 59 37.60	G. S.....	Bull. 122.
Canadian.....	59 03.60	35 15.10	do.....	Do.
Corazon.....	27 09.80	33 57.40	do.....	Do.
Montoya.....	43 21.00	09 43.30	do.....	Do.
	35°-36°	105°-106°		
Baldy.....	35 49 57.50	105 45 27.90	do.....	Do.
Bernal Hill.....	22 33.00	19 38.40	Wheeler.....	Final Rept.
Escobas Peak.....	32 02.00	42 45.00	do.....	Do.
Fort Union.....	54 24.86	00 51.15	Engr. Corps..	Rept. '73.
Jacinto.....	05 26.00	26 59.40	G. S.....	Bull. 122.
Las Truchas Mountain.....	57 40.70	38 39.10	Wheeler.....	Final Rept.
Las Vegas.....	35 27.66	13 27.57	do.....	Do.
Rincon.....	46 03.10	33 11.40	G. S.....	Bull. 122.
Santa Fe.....	41 19.29	56 45.22	Wheeler.....	Final Rept.
Thompson.....	40 22.10	48 22.90	G. S.....	Bull. 122.
Albuquerque:	35°-36°	106°-107°		
Armijo House, flagstaff.....	35 05 02.25	106 39 11.64	do.....	Bull. 49.
Grant Block, flagstaff.....	05 03.12	39 11.09	do.....	Do.
San Felipe Hotel, flagstaff, Gold avenue.....	04 59.78	39 21.02	do.....	Do.
Astronomic pier.....	04 32.40	39 12.47	do.....	Do.
Catholic church cross.....	05 09.70	39 23.04	do.....	Do.
Jemes.....	41 44.70	51 30.60	do.....	Do.
Placer Mountain.....	20 03.40	10 36.00	Wheeler.....	Final Rept.
Sandia.....	14 07.30	27 22.00	G. S.....	Bull. 122.
Tetilla Peak.....	36 24.30	13 00.80	Wheeler.....	Final Rept.
SW. corner sec. 17, T. 10 N., R. 3 E.....	05 13.26	39 35.66	G. S.....	Bull. 122.
	35°-36°	107°-108°		
Taylor.....	35 14 20.70	107 36 29.20	do.....	Do.
	35°-36°	108°-109°		
Astronomical pier.....	35 30 51.38	108 32 27.32	do.....	Do.
Chusca.....	53 06.70	50 14.50	do.....	Do.
East base.....	30 17.80	30 28.08	do.....	Do.
Fort Wingate, flagstaff.....	28 49.47	32 20.00	Wheeler.....	Final Rept.
Hosta.....	35 13.50	11 29.90	G. S.....	Bull. 122.
McKenzie.....	21 18.70	26 35.10	do.....	Do.
Nell.....	25 13.50	37 24.90	do.....	Do.
Pyramid.....	33 18.80	37 01.10	do.....	Do.
Square Mesa.....	13 07.70	16 46.90	do.....	Do.
Twins.....	29 39.80	50 04.50	do.....	Do.
West base.....	31 48.38	34 30.74	do.....	Do.
Zuni.....	07 25.90	54 40.30	do.....	Do.
	34°-35°	104°-105°		
Jospinto No. 1.....	34 56 42.00	104 57 10.00	do.....	Do.
Jospinto No. 2.....	56 36.80	56 57.20	do.....	Do.
	34°-35°	105°-106°		
Pedernal.....	34 50 44.00	105 38 38.30	do.....	Do.
Pedernal Peak.....	50 38.50	39 04.20	Wheeler.....	Final Rept.
Rattlesnake Hill.....	34 07.50	49 41.40	do.....	Do.
Tecolote Peak.....	04 37.00	41 44.00	do.....	Do.
	34°-35°	106°-107°		
Manzano Peak.....	34 35 23.20	106 27 12.20	do.....	Do.
Mosca Peak.....	48 36.50	24 34.50	do.....	Do.
Osha Peak.....	38 09.30	26 43.60	do.....	Do.
	34°-35°	107°-108°		
Ladrones.....	34 26 01.00	107 05 29.50	do.....	Do.
	34°-35°	108°-109°		
Pinon.....	34 11 51.10	108 27 52.10	G. S.....	Bull. 122.
	33°-34°	105°-106°		
Blanca Peak.....	33 22 24.00	105 48 55.00	Wheeler.....	Final Rept.
Capitan Peak.....	35 24.40	16 20.30	do.....	Do.
East Carrizo Cone.....	38 59.60	37 17.50	do.....	Do.
Fort Stanton, flagstaff.....	29 35.72	31 59.72	do.....	Do.
Nogal Peak.....	29 47.50	48 36.20	do.....	Do.
	33°-34°	106°-107°		
Colorado Mountain.....	33 50 42.00	106 42 06.00	do.....	Do.
Salinas Peak.....	17 50.60	32 15.00	do.....	Do.
	33°-34°	107°-108°		
Caballo Cone.....	33 06 01.80	107 13 40.40	do.....	Do.
Fort Craig, flagstaff.....	38 00.99	01 07.96	do.....	Do.

NEW MEXICO—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	33°-34° ° / "	107°-108° ° / "		
Fra Cristobal Mount	33 25 35.00	107 07 10.10	Wheeler	Final Rept.
Mount Magdalena	59 23.20	11 39.10	do	Do.
San Mateo Mountain	33 07.30	26 04.90	do	Do.
	33°-34°	108°-109°		
Eagle Peak	33 40 33.20	108 34 41.30	do	Do.
Horse Peak	58 38.20	07 29.90	do	Do.
Round Peak	40 28.70	06 06.70	do	Do.
Tuleroso	40 37.70	34 34.90	G. S	Bull. 122.
	32°-33°	105°-106°		
Cornuda	32 01 28.44	105 30 57.65	do	Do.
	32°-33°	106°-107°		
Organ Mountain	32 20 34.40	106 33 40.50	Wheeler	Final Rept.
	32°-33°	107°-108°		
Florida Peak	32 07 18.30	107 37 19.20	do	Do.
Mount Cooke	32 01.40	43 53.90	do	Do.
Sunday Cone	37 08.50	26 54.00	do	Do.
	32°-33°	108°-109°		
Bear Peak	32 50 00.70	108 21 31.60	do	Do.
Black Peak	54 26.00	09 46.90	do	Do.
Fort Bayard, astronomical monument	47 40.35	09 08.77	do	Do.
	31°-32°	106°-107°		
Rodadero Peak	31 47 10.30	106 32 31.70	do	Do.
	31°-32°	107°-108°		
Potrillo Peak	31 55 21.00	107 04 07.00	do	Do.
	31°-32°	108°-109°		
Hacheta Peak	31 37 58.20	108 23 57.00	do	Do.
Lalacha Peak	50 21.20	27 13.60	do	Do.

ARIZONA.

	36°-37° ° / "	109°-110° ° / "		
Calabasa	36 22 18.30	109 50 16.70	G. S	Bull. 122.
Pastora	47 25.10	09 52.80	do	Do.
Roof Butte	27 37.10	05 31.40	do	Do.
Sonsala	06 05.20	04 41.70	do	Do.
	36°-37°	110°-111°		
Wilson	36 12 48.30	110 09 13.60	do	Do.
	36°-37°	111°-112°		
Paria Needle	36 51 00.60	111 40 54.60	Powell	Do.
Paria Station	50 49.20	40 47.70	do	Do.
	36°-37°	112°-113°		
Brink	36 26 01.60	112 25 11.60	do	Do.
Brow	35 25.00	23 56.70	do	Do.
Duffer	56 50.10	00 50.20	do	Do.
Kanab:				
North	57 46.50	31 21.40	do	Do.
South	54 04.10	31 50.90	do	Do.
New	55 29.80	35 36.40	do	Do.
Pipe	52 37.30	48 37.40	do	Do.
Pipe Springs, camp near	51 36.34	42 57.00	Wheeler	Rept. 76.
Shinarump	57 53.90	26 45.00	Powell	Bull. 122.
Three Trees	59 27.60	41 51.30	do	Do.
	36°-37°	113°-114°		
Emma	36 15 50.20	113 10 12.40	G. S	Do.
	35°-36°	109°-110°		
Crofton	35 11 39.30	109 06 51.80	do	Do.
Douglas	09 08.60	52 35.10	do	Do.
Iola	26 18.40	38 10.60	do	Do.
Zilh Tusayan	53 11.70	14 55.10	do	Do.
	35°-36°	110°-111°		
Cottonwood	35 30 26.70	110 18 59.60	do	Do.
Oraibe	52 50.40	42 49.20	do	Do.
	35°-36°	111°-112°		
San Francisco	35 20 47.00	111 40 37.80	do	Do.
	35°-36°	112°-113°		
Bill Williams	35 11 59.60	112 12 15.40	do	Do.
Floyd	23 33.60	43 24.10	do	Do.
	35°-36°	113°-114°		
Hualapai	35 04 30.20	113 53 48.30	do	Do.

ARIZONA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	35°-36°	114°-115°		
	° ' "	° ' "		
Dead	35 16 30.30	114 43 20.30	G. S.	Bull. 122.
Fort Mohave	02 09.00	35 54.00	Wheeler	Final Rept.
Tipton	32 21.10	11 30.10	G. S.	Bull. 122.
	34°-35°	109°-110°		
Haseltine	34 59 24.30	109 26 43.10	do	Do.
	34°-35°	110°-111°		
Chevron	34 41 33.80	110 50 52.10	do	Do.
Sunset	54 14.70	57 39.80	do	Do.
Woodruff	47 56.70	02 31.10	do	Do.
	34°-35°	111°-112°		
Baker Butte	34 27 08.60	111 22 39.60	do	Do.
Mazatzal	03 45.70	27 38.50	do	Do.
	34°-35°	112°-113°		
Granite	34 38 17.00	112 33 08.30	do	Do.
Fort Whipple	33 06.12	27 10.20	Wheeler	Final Rept.
	34°-35°	113°-114°		
Aquarius	34 56 56.20	113 17 51.00	G. S.	Bull. 122.
	33°-34°	109°-110°		
Ord Peak	33 56 16.00	109 36 15.80	do	Do.
Thomas Peak	54 24.10	34 16.00	Wheeler	Final Rept.
	33°-34°	111°-112°		
Brown Peak	33 41 04.20	111 19 29.60	G. S.	Bull. 122.
	32°-33°	109°-110°		
Graham	32 41 58.90	109 52 18.90	Wheeler	Final Rept.

UTAH.

	41°-42°	111°-112°		
	° ' "	° ' "		
Barton Mountain	41 04 51.80	111 51 19.90	Wheeler	Final Rept.
Kimballs Mountain	57 40.00	13 57.00	do	Do.
Lake View Peak	57 35.90	14 07.30	Hayden	Rept. '77.
Naomi Peak	54 38.90	40 46.30	Wheeler	Final Rept.
North Lyon Peak	54 39.00	40 46.50	Hayden	Rept. '77.
North Ogden Mountain	21 44.80	57 53.00	Wheeler	Final Rept.
Observatory Peak	11 56.80	53 09.60	do	Do.
Ogden, stone post in observatory	13 08.56	59 56.10	L. S.	
Ogden Peak	11 56.70	53 09.50	Hayden	Rept. '77.
Porcupine Mountain	01 07.00	07 06.80	Wheeler	Final Rept.
Willard Peak	21 44.90	57 53.10	Hayden	Rept. '77.
	41°-42°	112°-113°		
Black Butte	41 55 36.00	112 07 37.00	Wheeler	Final Rept.
Blue Spring Peak	47 36.00	32 54.40	do	Do.
Box Elder Peak	38 05.90	01 07.30	do	Do.
Promontory Mountain	29 21.80	30 44.90	do	Do.
South Promontory Mountain	18 45.80	27 04.90	do	Do.
	41°-42°	113°-114°		
Clear Creek Mountain	41 41 22.50	113 44 44.00	do	Do.
Newfoundland Mountain	11 06.70	22 19.20	do	Do.
Tangent Peak	28 50.60	10 42.20	do	Do.
	40°-41°	111°-112°		
Camp Douglas:				
New flagstaff	40 45 47.50	111 50 14.22	do	Do.
Old flagstaff	45 47.58	50 14.07	do	Rept. '76.
Sundial	45 47.47	50 13.92	Engr. Corps	Do.
Provo (old Camp Rawlins)	13 47.84	40 27.00	Wheeler	Repts. '72-73.
Salt Lake City	46 04.00	53 47.10	C. & G. S.	Rept. '84.
Spanish Fork	05 13.50	31 40.70	Powell	Bull. 122.
West Twin Peak	35 44.40	43 41.80	Wheeler	Final Rept.
	40°-41°	112°-113°		
Antelope Island	40 57 40.40	112 13 12.10	do	Do.
Provo	13 47.84	40 27.00	do	Rept. '76.
	40°-41°	113°-114°		
Deep Creek	40 06 01.71	113 57 16.05	do	Do.
Desert Mountain	57 02.40	47 36.20	do	Final Rept.
	39°-40°	109°-110°		
Culmination	39 11 27.10	109 46 47.50	Powell	Bull. 122.
	39°-40°	110°-111°		
Bruin	39 38 37.10	110 20 56.40	do	Do.
Indian Head	51 44.20	53 26.40	do	Do.
Red Plateau	10 14.00	37 10.90	do	Do.

UTAH—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	39°-40° ° ' "	111°-112° ° ' "		
Bare Brush	39 04 08.70	111 18 39.10	Powell	Bull. 122.
Ephraim	23 25.60	45 06.60	do	Do.
Fayette	12 31.50	49 20.30	do	Do.
Gunnison:				
Astronomical station	09 25.62	49 15.00	Wheeler	Final Rept.
North	08 28.30	49 16.20	Powell	Bull. 122.
South	03 10.20	49 16.20	do	Do.
Jura	04 49.70	46 00.60	do	Do.
Musinia	02 08.30	34 40.60	do	Do.
Nebo	48 35.40	45 59.70	do	Do.
South Tent	23 29.10	21 28.20	do	Do.
Valley	05 38.30	56 20.00	do	Do.
	39°-40°	112°-113°		
Canyon Range	39 23 30.70	112 12 26.50	do	Do.
	38°-39°	109°-110°		
Peale	38 26 18.10	109 13 44.30	G. S.	Do.
Waas	32 21.20	13 39.70	do	Do.
Do	32 18.60	13 41.80	Powell	Do.
	38°-39°	110°-111°		
Ellen	38 07 14.30	110 48 53.60	do	Do.
	38°-39°	111°-112°		
Black Cap	38 57 16.30	111 49 15.70	do	Do.
Fort Cameron	16 53.34	44 00.31	Wheeler	Final Rept.
Hilgard	41 00.40	32 38.20	Powell	Bull. 122.
Marvine	40 02.90	38 28.30	do	Do.
Thousand Lake	24 58.50	28 45.30	do	Do.
	38°-39°	112°-113°		
Beaver, astronomical monument near center of public square.	38 16 23.28	112 38 35.90	Wheeler	Final Rept.
Belknap	25 06.60	24 45.50	Powell	Bull. 122.
Katherine	59 35.00	08 24.70	do	Do.
Richfield	46 11.40	02 27.00	Wheeler	Final Rept.
	37°-38°	109°-110°		
Abajo	37 50 22.50	109 27 43.70	G. S.	Bull. 122.
	37°-38°	110°-111°		
Navajo Mountain	37 02 02.90	110 52 08.70	do	Do.
Pennell	57 21.40	47 27.90	Powell	Do.
	37°-38°	111°-112°		
Table Cliff	37 41 08.70	111 54 08.60	do	Do.
	37°-38°	112°-113°		
Adams	37 55 53.80	112 12 20.90	do	Do.
Brian	40 49.30	49 53.10	do	Do.
John	02 52.50	30 56.70	do	Do.
Kanab, monument in square in front of Bishop's residence.	02 25.43	31 39.00	Wheeler	Rept. '76.
Little Creek	52 48.40	36 43.40	Powell	Bull. 122.
Mansard	02 52.30	25 22.00	do	Do.
Mollie	16 12.30	03 18.60	do	Do.
Navajo Well	03 36.70	16 45.00	do	Do.
Pink Cliff	25 02.70	19 21.10	do	Do.
Street	02 55.85	31 50.83	do	Do.
Tithing Yard	02 55.90	31 50.00	do	Do.
	37°-38°	113°-114°		
St. George	37 06 29.38	113 35 00.30	Wheeler	Final Rept.
Toquerville	15 19.88	16 20.90	do	Rept. '76.

NEVADA.

	41°-42° ° ' "	114°-115° ° ' "		
Pilot Knob	41 01 12.20	114 04 51.50	Wheeler	Final Rept.
	41°-42°	119°-120°		
Division Peak	41 05 46.10	119 15 31.50	do	Do.
Mahogany Mount	01 26.40	33 17.90	do	Do.
Forty-nine Peak	33 24.00	55 23.00	do	Do.
Piute Peak	16 43.00	03 23.00	do	Do.
Yellow Mesa Peak	50 05.00	37 15.80	do	Do.
	40°-41°	115°-116°		
Fort Halleck	40 48 34.35	115 19 34.05	do	Do.
Camp Ruby	03 38.63	31 06.75	do	Do.
Elko	49 38.44	45 37.20	do	Do.

NEVADA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	40°-41° ° ' "	116°-117° ° ' "		
Battle Mountain, astronomical monument.	40 38 18.74	116 56 13.50	Wheeler	Final Rept.
	40°-41°	117°-118°		
Granite Peak, south end	40 22 30.10	117 31 35.80	C. & G. S.	
Winnemucca, astronomical monument.	58 19.97	43 54.16	Wheeler	Do.
	40°-41°	118°-119°		
Star Peak (Indian Peak)	40 31 15.47	118 10 16.61	C. & G. S.	
	40°-41°	119°-120°		
Granite Peak	40 47 22.60	119 25 47.70	Wheeler	Do.
Tohakum Peak	10 40.20	27 07.60	do	Do.
State Line Peak	01 44.00	58 32.40	do	Do.
Do	01 42.10	58 45.40	G. S.	Bull. 122.
	39°-40°	115°-116°		
Hamilton	39 15 48.87	115 25 58.38	do	
Monte Cristo Mill	13 16.83	34 49.20	do	
	39°-40°	117°-118°		
Augusta Peak	39 32 18.58	117 55 11.91	C. & G. S.	
Austin, astronomical station	29 21.92	03 41.70	Wheeler	
Birchims Mount	08 53.60	28 33.50	do	Rept. '79.
Bunker Hill	15 05.02	07 35.83	C. & G. S.	
Cowles Peak	03 14.40	33 24.90	Wheeler	Do.
Desatoya:				
North Twin	22 04.20	45 36.80	C. & G. S.	
South Twin	21 49.41	45 34.53	do	
Emigrant Peak	24 10.20	23 20.10	Wheeler	Do.
Geneva Peak	21 27.00	04 14.90	do	Do.
Mount Grant	32 16.60	54 56.20	do	Do.
North Augusta	41 01.90	48 26.70	C. & G. S.	
Shoshone Peak:				
North	08 56.20	28 49.80	do	Do.
South	03 17.60	33 41.10	do	Do.
Toyabe Peak	21 28.71	04 32.74	do	Do.
	39°-40°	118°-119°		
Carson Sink	39 34 53.62	118 14 09.27	do	Do.
Carson Table	32 23.40	17 58.50	do	Do.
Fairview	13 24.86	09 10.77	do	Do.
Mount Lincoln	32 52.50	15 48.70	do	Do.
Tarogua Peak	34 51.70	13 54.20	Wheeler	Do.
	39°-40°	119°-120°		
Churchill Butte	39 20 16.30	119 17 32.20	do	Do.
Cleaver Peak	13 01.10	08 01.90	G. S.	Bull. 122.
Como	01 11.40	28 27.59	C. & G. S.	
Do	01 07.50	28 14.40	Wheeler	Final Rept.
Emma	17 39.30	36 00.90	do	Do.
Genoa	02 26.40	52 43.00	do	Do.
Genoa Peak	02 29.50	52 54.40	G. S.	Bull. 122.
McClellan Mountain	15 26.10	41 46.20	Wheeler	Final Rept.
Mount Davidson	18 21.90	39 37.20	do	Do.
Do	18 24.09	39 49.78	C. & G. S.	
Mount Lyon	07 33.20	28 12.40	Wheeler	Do.
Mount Rose	20 32.30	55 05.90	G. S.	Bull. 122.
Mucca, Elephant Peak	58 28.40	44 40.10	C. & G. S.	
Northeast base	25 43.00	25 39.00	Wheeler	Final Rept.
Pahrah	47 34.73	28 28.74	C. & G. S.	
Peavine Mountain	35 07.40	55 57.00	G. S.	Bull. 122.
Pond Summit	39 02.38	27 50.78	C. & G. S.	
Rawe Mountain	11 56.51	28 40.40	Wheeler	Final Rept.
Rocky Point	20 50.20	34 02.40	do	Do.
Rose Mountain	20 30.30	54 54.10	do	Do.
Sage	07 35.66	28 24.97	C. & G. S.	
Tibbie	22 08.60	31 54.60	Wheeler	Rept. '79.
Do	22 10.70	32 07.30	G. S.	Bull. 122.
Twotips Mount	42 52.80	09 46.60	Wheeler	Final Rept.
Two Tips, north summit	42 54.70	09 59.90	C. & G. S.	
Virginia City, astronomical monument.	17 35.92	39 06.35	do	
Virginia Peak	45 14.95	27 41.60	do	
Washoe Peak, monument	20 32.24	55 05.68	do	
	38°-39°	117°-118°		
Lone Mountain	38 01 22.26	117 29 41.77	do	Do.
Paradise Peak	48 15.90	49 22.70	Wheeler	Do.
Poston Mount	49 48.40	20 56.00	do	Do.
Toyabe Dome	49 52.29	21 12.85	C. & G. S.	
	38°-39°	118°-119°		
Basalt Peak	38 59 09.80	118 25 59.00	Wheeler	Do.
Black Mount	56 19.40	54 39.60	G. S.	Bull. 122.

NEVADA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	38°-39°	118°-119°		
	° ' "	° ' "		
Cory Mount.....	38 33 57.40	118 47 15.90	Wheeler.....	Final Rept.
Mount Grant.....	34 07.83	47 30.60	C. & G. S.....	
Mount Hull (Cory's Peak).....	26 47.70	46 58.10	do.....	
Pilot Cone.....	59 12.86	26 14.06	do.....	
Volcano.....	23 37.50	09 35.20	do.....	
Wassuck, south peak.....	46 57.92	50 05.57	do.....	
	38°-39°	119°-120°		
	° ' "	° ' "		
Desert Creek Peak.....	38 36 45.20	119 18 58.00	G. S.....	Bull. 122.
Mount Wilson.....	50 57.90	13 14.50	do.....	Do.
Saddle Galena.....	53 17.41	30 09.33	C. & G. S.....	
Silver Lake Mountain.....	51 45.00	28 34.00	Wheeler.....	Final Rept.
	37°-38°	114°-115°		
	° ' "	° ' "		
Pioche, observatory.....	37 55 26.07	114 26 18.27	do.....	Do.
	37°-38°	117°-118°		
	° ' "	° ' "		
Montezuma Peak.....	37 41 35.50	117 21 45.70	C. & G. S.....	
	36°-37°	115°-116°		
	° ' "	° ' "		
Charleston.....	36 16 18.00	115 41 38.70	G. S.....	Bull. 122.

IDAHO.

	44°-45°	115°-116°		
	° ' "	° ' "		
Packer John.....	44 10 52.00	115 47 24.25	G. S.....	Bull. 122.
	44°-45°	116°-117°		
	° ' "	° ' "		
Big Willow.....	44 12 20.60	116 27 02.71	do.....	Do.
Squaw.....	00 09.66	24 45.96	do.....	Do.
Middle Weiser.....	42 37.77	16 14.15	do.....	Do.
Weiser.....	15 56.20	54 05.40	do.....	Do.
	43°-44°	111°-112°		
	° ' "	° ' "		
Baird, Mount.....	43 21 46.70	111 05 54.80	Hayden.....	Rept. '77.
Caribou Mountain.....	05 36.20	18 56.70	do.....	Do.
	43°-44°	113°-114°		
	° ' "	° ' "		
Big Butte.....	43 23 42.20	113 01 38.00	Wheeler.....	Final Rept.
	43°-44°	114°-115°		
	° ' "	° ' "		
Green Spring.....	43 12 48.03	114 54 49.34	G. S.....	Bull. 122.
Kelly, Mount.....	29 30.71	28 04.61	do.....	Do.
Smoky Dome.....	29 33.93	56 14.94	do.....	Do.
Snowy Side.....	56 16.25	58 21.50	do.....	Do.
	43°-44°	115°-116°		
	° ' "	° ' "		
Camas.....	43 14 54.66	115 26 08.64	do.....	Do.
Cinder.....	13 07.26	59 40.65	do.....	Do.
House.....	25 57.75	29 21.53	do.....	Do.
North.....	35 54.90	25 48.56	do.....	Do.
Three Point.....	30 21.70	56 07.48	do.....	Do.
	43°-44°	116°-117°		
	° ' "	° ' "		
Boise, astronomical pier.....	43 35 57.98	116 13 04.04	do.....	Do.
Caldwell.....	42 16.52	41 46.82	do.....	Do.
East base.....	32 43.47	10 19.64	do.....	Do.
Flat Top.....	15 44.31	53 11.56	do.....	Do.
Initial Point.....	22 18.20	23 42.80	do.....	Do.
Lucky Peak.....	36 17.84	03 45.61	do.....	Do.
Pickels Butte.....	29 18.21	42 49.56	do.....	Do.
Shafer.....	46 16.45	05 25.26	do.....	Do.
South Ridge, 1.....	30 50.88	13 43.64	do.....	Do.
South Ridge, 2.....	28 28.67	06 47.39	do.....	Do.
Star.....	46 23.49	25 00.00	do.....	Do.
Table Rock.....	35 35.69	08 45.34	do.....	Do.
West base.....	35 14.19	14 49.70	do.....	Do.
	42°-43°	111°-112°		
	° ' "	° ' "		
Bear Valley base:				
East end.....	42 27 18.90	111 19 48.00	Hayden.....	Rept. '77.
West end.....	27 22.70	22 04.00	do.....	Do.
Castle Rock.....	12 09.00	33 08.00	Wheeler.....	Final Rept.
East Hill.....	28 49.70	19 19.60	Hayden.....	Rept. '77.
North Hill.....	31 15.60	24 54.50	do.....	Do.
Paris Peak.....	12 08.80	33 11.80	do.....	Do.
Preuss Mount.....	29 42.60	15 11.00	do.....	Do.
Sedgwick Peak.....	30 54.00	55 39.90	Wheeler.....	Final Rept.
Soda Peak.....	27 53.70	33 11.40	Hayden.....	Rept. '77.
South Hill.....	23 41.10	23 34.40	do.....	Do.

IDAHO—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	42°-43° ° / "	112°-113° ° / "		
Bannock Peak.....	42 36 08.80	112 42 43.00	Wheeler.....	Final Rept.
Deep Creek Mountain.....	28 13.10	39 37.70	do.....	Do.
Elkhorn Mountain, north point.....	20 00.30	19 56.60	do.....	Do.
Oxford Peak.....	16 07.60	06 05.40	do.....	Do.
Putnam, Mount.....	57 10.60	10 09.40	Hayden.....	Rept. '77.
South Putnam Peak.....	55 03.40	07 58.60	Wheeler.....	Final Rept.
	42°-43° ° / "	113°-114° ° / "		
Badger Peak.....	42 33 00.90	113 04 01.00	do.....	Do.
Black Pine Mountains.....	07 08.50	07 27.90	do.....	Do.
Cache Peak.....	11 04.10	39 54.80	do.....	Do.
Cedar Creek Mountain.....	26 46.10	03 34.60	do.....	Do.
Pillar Butte.....	52 57.70	13 08.70	do.....	Do.
	42°-43° ° / "	116°-117° ° / "		
Quicksilver.....	42 58 48.47	116 33 32.46	G. S.....	Bull. 122.

WASHINGTON.

	47°-48° ° / "	117°-118° ° / "		
Spokane Falls, monument one-fourth mile east of the town.	47 39 38.13	117 24 45.89	Engr. Corps.	Rept. '82.
	47°-48° ° / "	122°-123° ° / "		
Seattle.....	47 35 57.20	122 19 58.70	C. & G. S.....	
Steilacoom:				
Presbyterian church.....	10 24.08	35 35.76	do.....	
Methodist church.....	10 23.03	35 50.88	do.....	
	46°-47° ° / "	117°-118° ° / "		
Colfax, monument on an island in Palouse River, at north end of the town.	46 53 13.69	117 23 29.13	Engr. Corps.	Do.
	46°-47° ° / "	118°-119° ° / "		
Wallawalla.....	46 03 55.89	118 20 50.14	Wheeler.....	Final Rept.
	46°-47° ° / "	122°-123° ° / "		
Kalama.....	46 00 17.80	122 50 33.20	C. & G. S.....	
	46°-47° ° / "	123°-124° ° / "		
Alamicut River.....	46 18 03.13	123 41 59.19	do.....	
Astoria Point.....	11 23.65	50 29.35	do.....	
Bakers Bay.....	16 27.50	55 49.17	do.....	
Base on east end.....	18 12.74			

OREGON.

	45°-46° ° / "	121°-122° ° / "		
Dalles.....	45 35 50.80	121 13 11.20	Wheeler.....	Final Rept.
	42°-43° ° / "	120°-121° ° / "		
Baldy.....	42 07 03.70	120 43 06.90	G. S.....	Bull. 122.
High Rock.....	29 42.70	52 40.40	do.....	Do.
Lolochevis Mountain.....	18 22.00	37 38.00	Wheeler.....	Final Rept.
North End Mountain.....	03 54.00	14 13.00	do.....	Do.
Sugarloaf Mountain.....	17 57.60	07 12.40	do.....	Do.
	42°-43° ° / "	122°-123° ° / "		
Pitt.....	42 26 36.40	122 18 58.40	G. S.....	Bull. 122.
Scott.....	55 18.90	01 00.20	do.....	Do.
	42°-43° ° / "	123°-124° ° / "		
Kirby.....	42 13 08.20	123 27 42.60	do.....	Do.

CALIFORNIA.

	41°-42° ° / "	120°-121° ° / "		
Alturas Hill.....	41 28 57.70	120 32 43.00	Wheeler.....	Final Rept.
Bidwell Mount.....	56 52.60	07 49.80	do.....	Do.
Bidwell Fort, flagstaff.....	51 30.84	09 15.56	do.....	Do.
Cedar Mount.....	36 31.90	16 00.20	do.....	Do.
Eagle Mountain.....	16 56.00	11 51.40	do.....	Do.
Hat Mountain.....	03 57.00	05 47.90	do.....	Do.

CALIFORNIA—Continued.

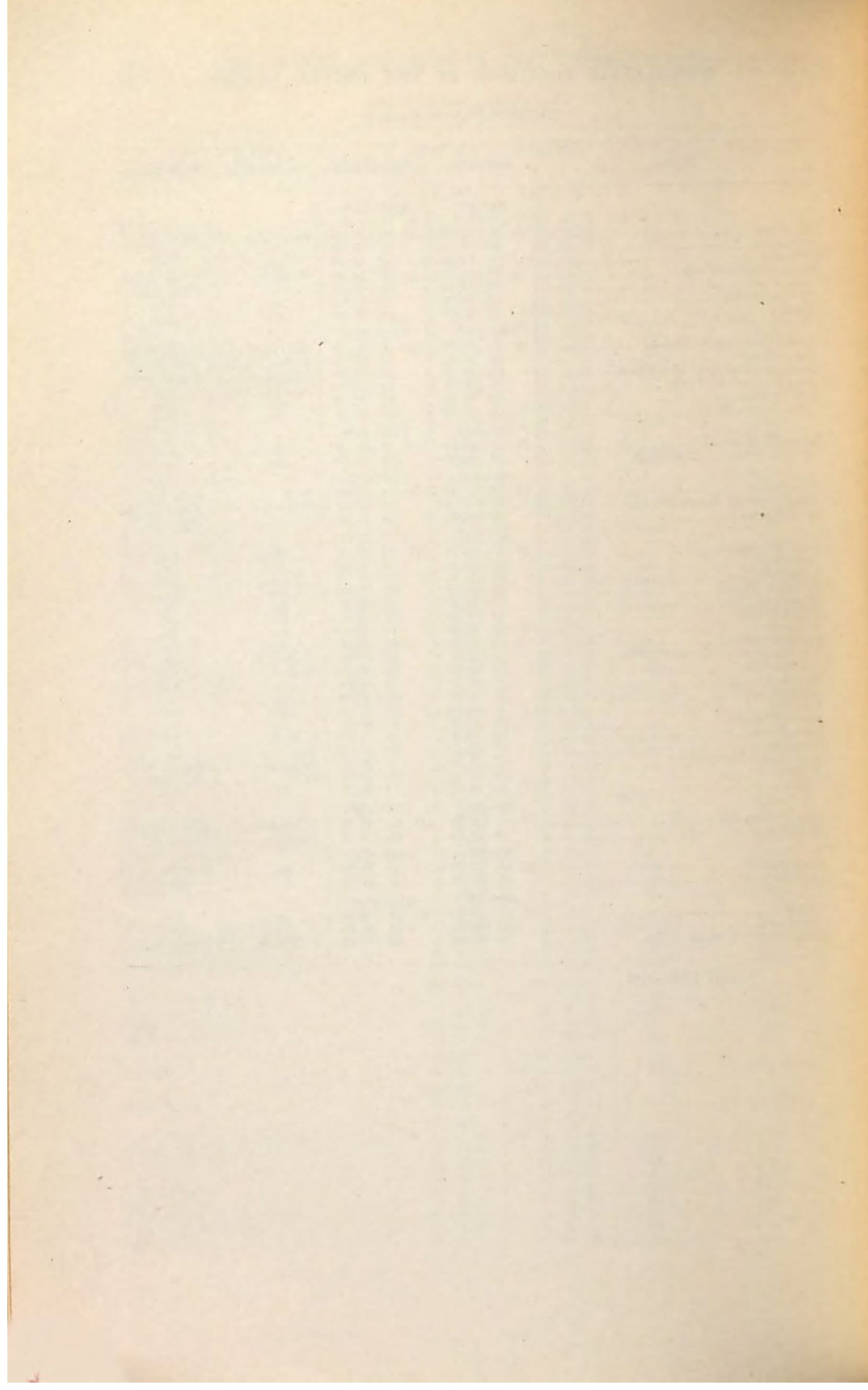
Name.	Latitude.	Longitude.	Authority.	Reference.
	41°-42° ° / "	122°-123° ° / "		
Shasta	41 24 27.60	122 11 42.90	G. S.	Bull. 122.
	40°-41°	120°-121°		
Fredonyer Peak	40 41 11.00	120 35 44.40	Wheeler	Final Rept.
Hot Springs Peak	22 24.80	07 07.30	do	Do.
Kettle Rock Peak	08 42.00	43 03.10	do	Do.
McKesick Peak	05 22.90	14 43.10	do	Do.
McDonald Peak	56 23.20	24 35.70	do	Do.
Observation Peak	46 22.20	10 06.90	do	Do.
Schaffer Mount	26 43.10	21 18.60	do	Do.
South Fork Mountain	09 14.30	33 39.50	do	Do.
Thompson Peak	15 34.10	33 17.40	do	Do.
Warren Peak	22 38.70	12 59.60	do	Do.
	40°-41°	121°-122°		
Butt Mountain	40 12 58.20	121 23 02.10	do	Do.
Dyer Mount	14 15.20	01 48.40	do	Do.
Hoffman Butte	36 35.70	33 13.50	G. S.	Bull. 122.
Lassen Butte	29 11.21	30 16.21	C. & G. S.	Do.
	40°-41°	122°-123°		
Linn	40 02 05.70	122 51 16.50	G. S.	Do.
	40°-41°	123°-124°		
Thompson	40 58 15.20	123 00 09.90	do	Do.
	40°-41°	124°-125°		
Eureka, Methodist church	40 48 11.00	124 09 41.00	C. & G. S.	
	39°-40°	120°-121°		
Adams Mountain	39 54 32.20	120 05 43.20	Wheeler	Final Rept.
Banner Hill	14 39.40	57 56.60	G. S.	Bull. 122.
Castle Peak	21 48.60	20 47.30	Wheeler	Final Rept.
Crystal Peak	28 20.90	02 13.50	do	Do.
Downieville	35 29.80	38 39.30	do	Do.
Duncan Peak	08 32.10	30 33.90	G. S.	Bull. 122.
Fillmore	43 43.50	51 10.30	do	Do.
Haskell Peak	39 40.70	33 01.00	Wheeler	Final Rept.
Ingalls	59 33.70	37 40.10	G. S.	Bull. 122.
Lola	25 53.34	21 55.50	C. & G. S.	
Omjumi Peak	56 14.78	17 08.00	G. S.	Do.
Summit Peak	42 03.50	08 37.30	do	Do.
Twin Peak	06 39.30	13 56.30	do	Do.
Wellington Mountain	51 59.90	31 40.60	Wheeler	Final Rept.
	39°-40°	121°-122°		
Big Bar Hill	39 46 32.70	121 25 40.00	G. S.	Bull. 122.
Chico	43 25.20	50 51.30	do	Do.
Marysville Butte	12 15.70	49 15.40	do	Do.
Pike County Peak	38 24.30	12 10.00	do	Do.
Rock Mountain	03 28.00	13 58.00	do	Do.
	38°-39°	119°-120°		
Cary Peak, Monument Peak	38 44 13.42	119 52 21.99	C. & G. S.	
Dunderberg Peak	03 43.20	16 16.60	Wheeler	Final Rept.
Dardanelles Cone	24 11.50	52 20.70	G. S.	Bull. 122.
Elephant Mount	39 40.00	59 54.00	Wheeler	Final Rept.
Freels Peak, Jobs Peak	51 21.79	54 01.84	C. & G. S.	
Highland Peak	32 31.94	45 21.40	G. S.	Bull. 122.
Leviathan	40 54.70	36 43.70	do	Do.
Silver Mountain :				
North Peak monument	33 56.66	45 29.68	C. & G. S.	
South Peak monument	32 31.94	45 21.31	do	Do.
Sonora	21 08.25	38 09.18	G. S.	Bull. 122.
Stevens Mountain	43 52.90	58 44.40	Wheeler	Final Rept.
Sweet Water	26 07.60	18 19.60	C. & G. S.	
	38°-39°	120°-121°		
Alder Hill	38 37 40.00	120 16 40.84	G. S.	Bull. 122.
Bald Mountain	54 09.20	42 19.20	do	Do.
Baltic Peak	41 33.60	30 57.00	do	Do.
Bear Mountain	01 08.50	35 08.40	do	Do.
Blue Mountain	20 26.20	21 55.00	do	Do.
Buena Vista	16 06.80	54 51.80	do	Do.
Crossman	27 49.20	32 01.00	do	Do.
Jackson	20 18.30	43 17.40	do	Do.
Joaquin	08 15.20	41 24.90	do	Do.
Mokelumne Peak	32 12.12	05 41.34	do	Do.
Pine Hill	43 04.40	59 26.70	do	Do.
Pyramid Mountain	50 32.60	09 20.60	Wheeler	Final Rept.
Robb Peak	55 24.30	24 14.00	G. S.	Bull. 122.
Round Top	39 43.63	00 04.99	C. & G. S.	
Sugar Loaf	34 43.00	56 59.30	G. S.	Do.
Capitol	34 30.70	29 38.10	do	Do.

CALIFORNIA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	38°-39° ° ' "	122°-123° ° ' "		
Helena	38 40 04.26	122 38 01.41	C. & G. S.	
Sulphur Peak	45 46.74	50 40.84	do	
Vaco	22 27.02	05 05.61	do	
	38°-39°	123°-124°		
Ross Mountain	38 30 13.03	123 07 09.77	do	
Sanel	56 48.23	13 00.87	do	
	37°-38°	118°-119°		
McBride Peak	37 50 08.00	118 21 12.60	Wheeler	Final Rept.
Morgan Mount	24 07.20	43 46.90	do	Do.
Waucoba Peak	01 07.80	00 23.20	do	Do.
White Mountain:				
North summit	50 13.77	21 26.34	C. & G. S.	
South summit	37 57.60	15 22.10	do	
	37°-38°	119°-120°		
Chiquita Peak	37 20 46.80	119 25 31.80	Wheeler	Do.
Clark Peak	41 42.00	25 44.10	G. S.	Bull. 122.
Cloud Rest	45 53.20	29 11.80	Wheeler	Final Rept.
Conness	57 55.97	19 18.10	C. & G. S.	
Cottonwood Peak	55 30.90	44 07.30	G. S.	Bull. 122.
Dana	53 54.30	13 17.40	C. & G. S.	Do.
Deadwood Peak	18 36.70	41 00.20	Wheeler	Final Rept.
Devils Peak	31 40.20	44 26.90	G. S.	Bull. 122.
Engineer Peak	49 55.00	23 35.00	Wheeler	Rept. '79.
Green Mountain Peak	15 43.60	59 19.60	do	Do.
Hoffman	50 43.50	30 39.20	G. S.	Bull. 122.
Lyell	44 16.60	16 19.00	do	Do.
Merced Mountain	37 54.90	23 30.60	Wheeler	Final Rept.
Pilot Peak	45 39.80	56 10.90	G. S.	Bull. 122.
Wade Peak	51 08.50	47 16.90	Wheeler	Final Rept.
	37°-38°	120°-121°		
Big Canyon	37 58 01.50	120 07 13.00	G. S.	Bull. 122.
Big Hill	49 37.30	34 08.80	do	Do.
Bullion Peak	33 27.60	04 33.70	do	Do.
Moccasin Peak	48 12.50	19 43.00	do	Do.
Schultz Mount	26 33.10	08 32.90	Wheeler	Final Rept.
	37°-38°	121°-122°		
Hamilton	37 20 23.00	121 30 31.35	do	Do.
Mount Diablo	52 48.70	54 51.95	C. & G. S.	
San Jose, mission church	32 00.08	54 10.27	do	
Santa Clara, Catholic spire	20 49.00	56 26.00	do	
	37°-38°	122°-123°		
Bald	37 52 56.19	122 13 20.48	G. S.	Do.
Lawson Hill	56 34.00	11 36.00	do	Do.
Monument South	50 55.88	11 35.52	do	Do.
Mulholland Hill	51 26.00	08 36.00	do	Do.
Redwood Peak	49 00.00	10 37.00	do	Do.
Rocky Island	53 42.00	21 21.00	do	Do.
Striped Hill	56 49.00	17 17.00	do	Do.
Yerba Buena	48 30.00	21 59.00	do	Do.
	36°-37°	117°-118°		
Maturango Mountain	36 06 56.30	117 29 49.90	Wheeler	Do.
New York Butte	38 40.80	55 56.40	do	Do.
Telescope Mountain	09 52.40	05 27.20	do	Do.
Wahguyhe Mountain	56 03.50	06 15.60	do	Do.
	36°-37°	118°-119°		
Corcoran Mount	36 31 14.00	118 14 23.80	do	Do.
Olancha Peak	15 43.80	07 10.20	do	Do.
Thunder Mountain	04 52.20	34 40.70	do	Do.
Whitney Mount	34 33.00	17 32.00	do	Do.
	36°-37°	119°-120°		
Fresno	36 43 31.22	119 47 19.50	do	Repts. '79, '80
	35°-36°	117°-118°		
Pilot Knob	35 23 32.10	117 13 49.70	do	Final Rept.
	35°-36°	118°-119°		
Camp Weldon (mountain)	35 40 01.00	118 17 05.00	do	Do.
Cooks Point (mountain)	37 09.00	26 30.40	do	Do.
Nichols Point	37 00.50	18 05.20	do	Do.
Owens Peak	44 05.40	00 00.50	do	Do.
Pahute Peak	28 37.60	21 49.80	do	Do.
Sunday Peak	46 48.50	35 17.30	do	Do.
Tehachapai Double Peak	01 47.00	29 25.50	do	Do.
Tehachapai Mount	02 21.30	34 35.60	do	Do.
Grizzly Peak	05 52.70	50 54.70	do	Do.

CALIFORNIA—Continued.

Name.	Latitude.	Longitude.	Authority.	Reference.
	34°-35° ° / "	117°-118° ° / "		
Jurupa	34 01 51.60	118 26 37.10	G. S	Bull. 122.
Pomona	00 58.00	46 54.00	do	Do.
Potato	01 14.00	17 52.00	do	Do.
San Antonio Peak	17 06.20	39 14.10	Wheeler	Final Rept.
San Jose	03 17.00	51 06.00	G. S	Bull. 122.
Strawberry	13 49.00	14 10.00	do	Do.
Zanja	03 32.00	04 09.00	do	Do.
	34°-35° ° / "	118°-119° ° / "		
Disappointment Peak	34 14 49.80	118 06 54.80	Wheeler	Final Rept.
Raymond	07 20.00	08 57.00	G. S	Bull. 122.
Saddle (Malaga) Mountain	04 33.50	39 17.20	Wheeler	Final Rept.
San Fernando Peak	19 39.30	36 01.90	do	Do.
Sister Else	16 00.00	14 19.60	do	Do.
Workman Hill	00 48.40	01 14.50	do	Do.
	34°-35° ° / "	119°-120° ° / "		
McGill Mount	34 48 43.90	119 08 52.60	do	Do.
White Granite Mountain	36 34.00	07 55.10	do	Do.
	33°-34° ° / "	116°-117° ° / "		
Roderick	33 13 56.40	116 54 14.00	G. S	Bull. 122.
San Jacinto Mountain	49 07.90	42 22.20	Wheeler	Final Rept.
Woodson	00 25.10	58 17.80	G. S	Bull. 122.
	33°-34° ° / "	117°-118° ° / "		
Box Springs	33 57 36.10	117 16 54.00	do	Do.
Burnt	12 04.40	04 00.90	do	Do.
Centipede	09 32.00	00 18.00	do	Do.
Double Butte	43 21.00	07 28.00	do	Do.
Elsinore	36 03.10	20 39.80	do	Do.
High Knob	12 38.10	11 06.50	do	Do.
Kelley	09 42.30	19 23.80	do	Do.
Lancaster	19 13.20	08 08.50	do	Do.
Los Angeles, SE. base (1890)	47 28.38	56 36.08	C. & G. S	Do.
Margarita	26 34.50	23 30.00	G. S	Do.
Mora	17 54.40	16 14.70	do	Do.
Niguel	30 39.30	44 06.80	do	Do.
Onofre	21 44.80	29 45.50	do	Do.
San Joaquin	36 15.40	48 46.90	do	Do.
San Juan	54 43.90	44 21.08	C. & G. S	Do.
Santiago	42 32.40	32 07.00	G. S	Do.
Temescal Mountain	42 31.00	32 04.00	Wheeler	Rept. '79.
Whitney	06 25.90	09 22.20	G. S	Bull. 122.
Wire	13 31.40	22 05.30	do	Do.
	33°-34° ° / "	118°-119° ° / "		
San Pedro Hill	33 44 39.20	118 20 07.80	Wheeler	Final Rept.
Workman	59 24.00	00 14.00	G. S	Bull. 122.
	32°-33° ° / "	116°-117° ° / "		
Cuyamaca	32 56 42.20	116 36 26.70	do	Do.
San Miguel	41 41.00	56 14.00	do	Do.
	32°-33° ° / "	117°-118° ° / "		
Black	32 58 47.40	117 07 02.00	do	Do.
Cowles	48 39.90	01 58.00	do	Do.
San Diego, transit	43 06.00	09 40.80	C. & G. S	Rept. '84.



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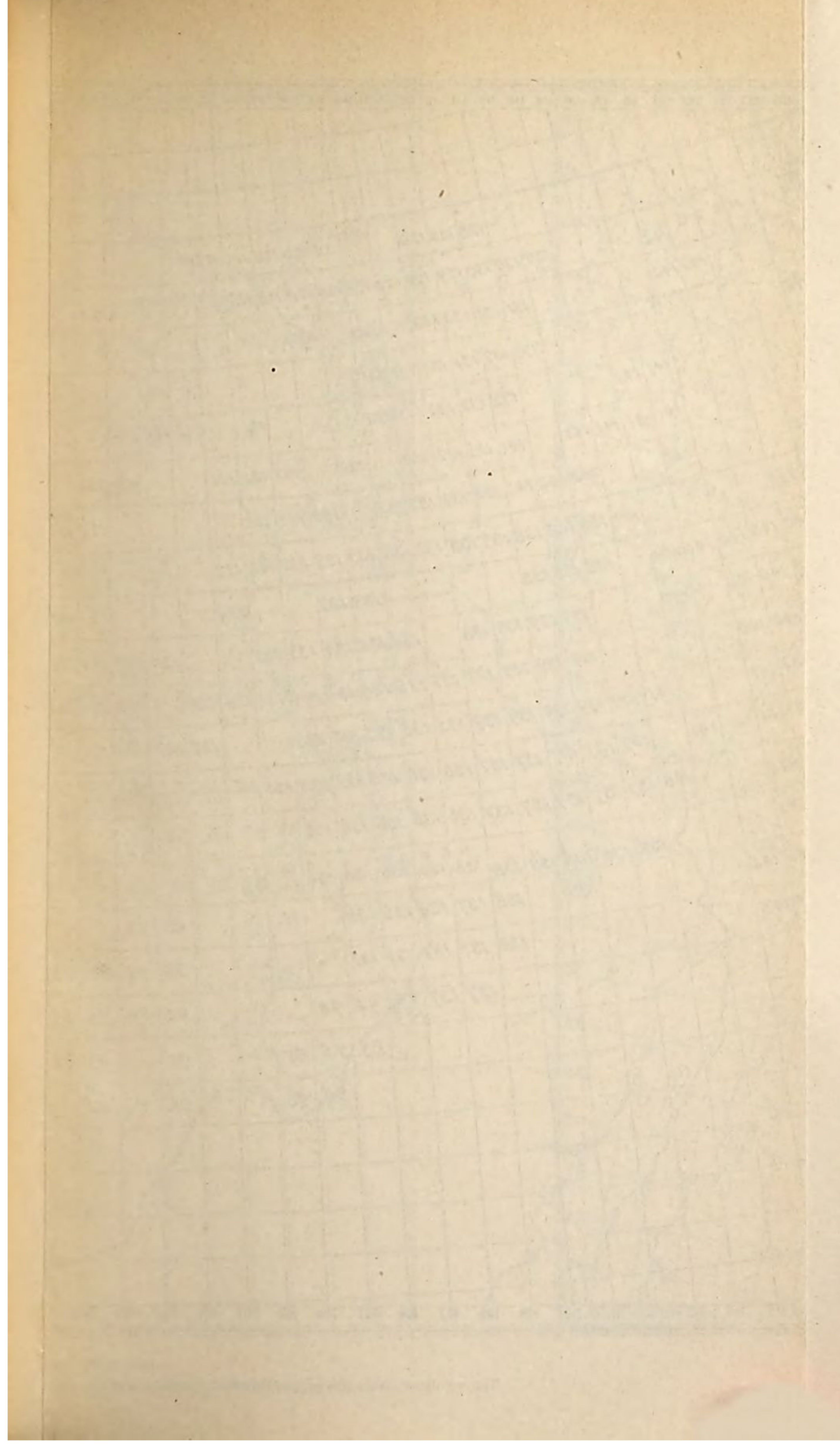
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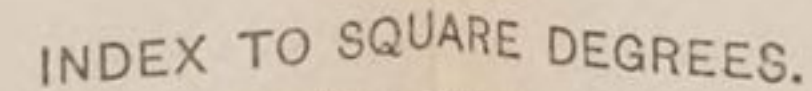
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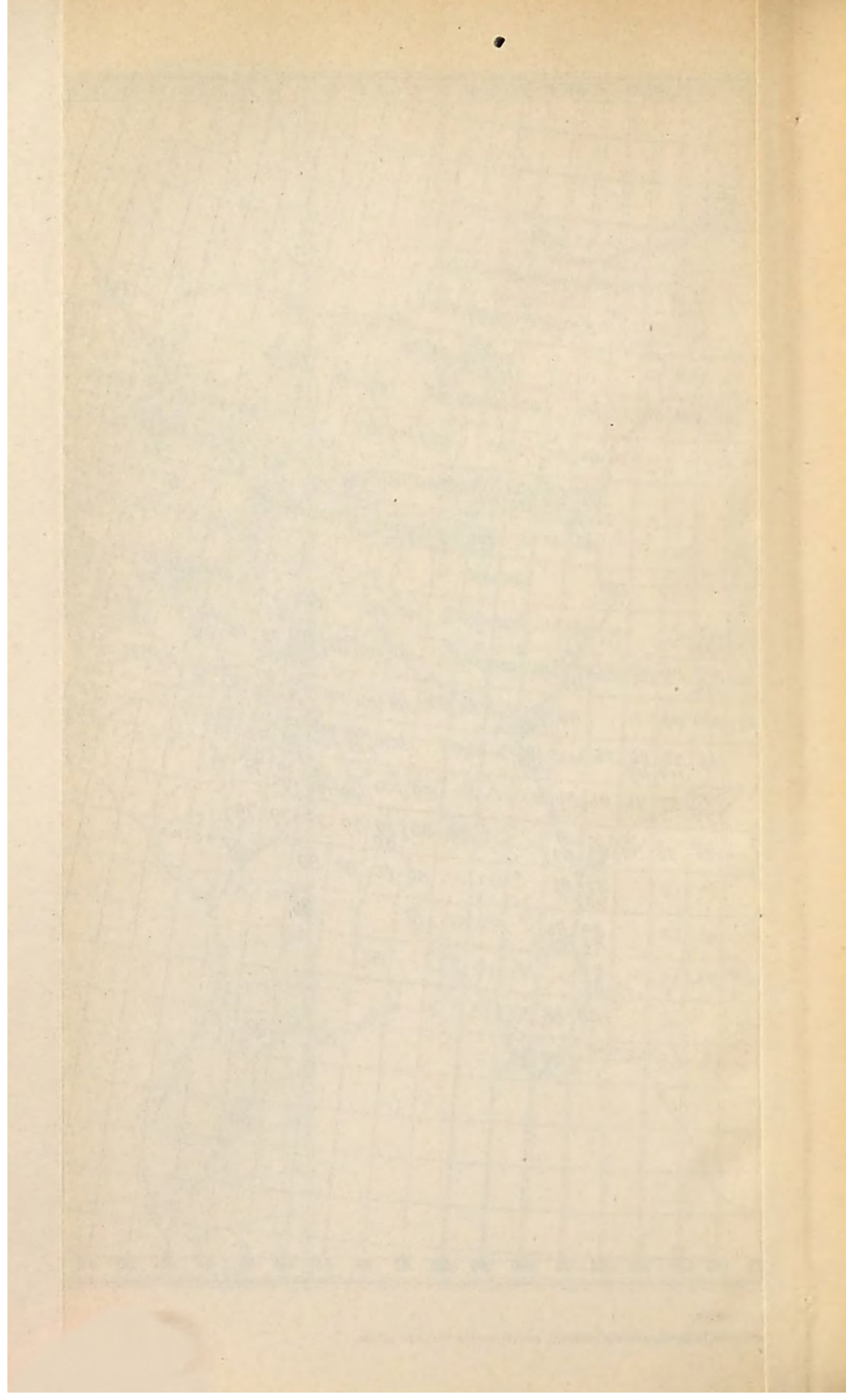
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No. 124

REVISION OF THE AMERICAN FOSSIL COCKROACHES, WITH
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1896

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The statute approved March 3, 1879, establishing the United States Geological Survey, contains the following provisions:

"The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos. Three thousand copies of each shall be published for scientific exchanges and for sale at the price of publication; and all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization; and the money resulting from the sale of such publications shall be covered into the Treasury of the United States."

Except in those cases in which an extra number of any special memoir or report has been supplied to the Survey by resolution of Congress or has been ordered by the Secretary of the Interior, this office has no copies for gratuitous distribution.

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UNITED STATES GEOLOGICAL SURVEY

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REVISION

OF THE

AMERICAN FOSSIL COCKROACHES

WITH

DESCRIPTIONS OF NEW FORMS

BY

SAMUEL HUBBARD SCUDDER



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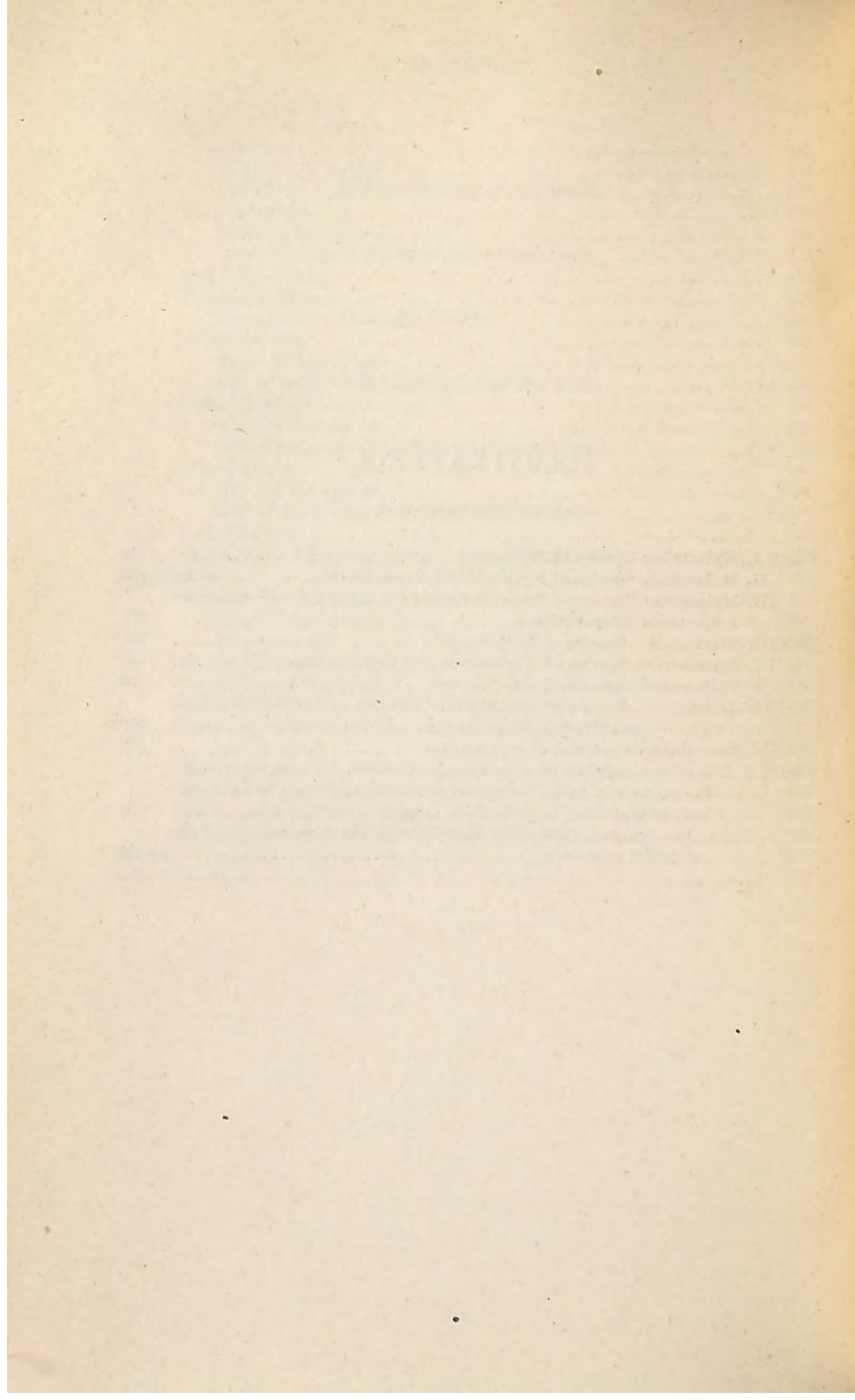
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LETTER OF TRANSMITTAL.

CAMBRIDGE, MASS., *November 7, 1893.*

SIR: I send herewith for publication as a bulletin, if acceptable to you, the manuscript of a paper, and drawings to illustrate it, upon the fossil cockroaches of North America. The paper was partially completed and most of the drawings were made at the termination of my connection with the Survey, and has since been finished in such leisure as I could command.

Yours, respectfully,

SAMUEL H. SCUDDER.

To the DIRECTOR U. S. GEOLOGICAL SURVEY,
Washington, D. C.

REVISION OF THE AMERICAN FOSSIL COCKROACHES.

By SAMUEL HUBBARD SCUDDER.

INTRODUCTION.

When, in 1879, I published my *Paleozoic Cockroaches*,¹ in which a revision of the species of the whole world was attempted, I had seen but nineteen specimens from North America, belonging to seventeen species and seven genera. To-day more than three hundred American specimens have passed under my eye, besides fifty from the Triassic rocks and a very few from the Tertiary series; and from the Paleozoic series alone there are here recognized one hundred and thirty-two species (not including some indeterminate forms) belonging to fourteen genera. As I have published from time to time in various places, but principally in the *Memoirs of the Boston Society of Natural History* (collected in Vol. I of my *Fossil Insects of North America*), a considerable number of species, and as a still larger number have since accumulated, thanks to recent exploitation of the Carboniferous deposits of eastern America, it has seemed advisable, in publishing the new forms, to bring together, either by reference or by description and figure, the whole body of information at present available, in order to gain a place for a new departure.

Accordingly, I have interpolated the descriptions of new forms in a systematic list of all the species yet recovered from the rocks and have added such tables as may enable one the more readily to determine any new material that may come to hand and to make comparisons with such as prove their nearest allies. With the publication of this essay, moreover, all the species hitherto described will have been figured. All the additions made at the present time belong to the Paleozoic forms. Several species before described are here figured for the first time.

NEW LOCALITIES FOR FOSSIL COCKROACHES.

The recent extension of our knowledge of our Paleozoic cockroaches is very largely due to the exploitations of two localities, one in West Virginia, through the instrumentality of Mr. R. D. Lacoë, of Pittston, Pa., the other in Ohio, through the labors of Mr. Samuel Huston, of Steubenville.

¹ *Mem. Bost. Soc. Nat. Hist.*, III, 23-134, pl. 2-6; *Foss. Ins. N. A.*, I, 43-153, pl. 2-6.

The West Virginia locality is at Cassville, Monongalia County, not far from Morgantown, and the specimens were found in rocks lying above the Waynesburg coal, in what is termed by Prof. I. C. White the Dunkard Creek series, and referred very positively by him and Prof. W. M. Fontaine to the Permian. The blattarian fauna as thus far determined is unquestionably younger than any known from the Pennsylvania and Illinois rocks, on which we have hitherto depended largely for our knowledge, and consists of a vast assemblage of forms, which will undoubtedly be increased by further search. They number fifty-six species, belonging to five genera, the bulk of them (thirty-six species) to *Etoblattina*.

The Ohio locality lies at the edge of the township of Richmond, on Wills Creek, in the near neighborhood of Steubenville, Jefferson County, and though far less extensive and less thoroughly worked than Cassville, has already yielded twenty-two species belonging to three genera, of which the larger number (seventeen) belong to *Etoblattina* and the others to the genera represented at Cassville by more than a single species.

It is a curious fact, to which I called partial attention when first describing some of them, that these species represent for the most part a distinct group of cockroaches of the genera *Etoblattina* and *Gera-blattina*, characterized by great length and slenderness of the interno-median area, by a remarkable openness of the neuration in the middle of the tegmina, and by their frequently exceptional length and slenderness. They comprise, indeed, nearly 75 per cent of the species in these two genera at Richmond, and hardly occur elsewhere excepting at Cassville, where they compose about 25 per cent of the species of these two genera. The only occurrence of a similar form in Europe is *Etoblattina elongata* from the lower Dyas of Weissig, Saxony. The occurrence of this type of cockroaches is the characteristic feature of Richmond, and must place this fauna high in the series, as the stratigraphical evidence itself warrants. Its horizon, according to Mr. Huston, who alone has carefully explored the location, is in the Barren Coal-measures, a little above the crinoidal limestone.

It is remarkable that, notwithstanding the close relationship in general features of the two rich faunas of Cassville and Richmond, not a single species has been found common to the two. One species, indeed, I formerly regarded as found in both, but a closer study convinces me that there are in this case two very nearly allied forms, and they are accordingly separated in the present paper. Further than this, with one or two exceptions,¹ no American species has been found in two different places, and without exception the American species are completely distinct from the European.

¹One of these is *Etoblattina balteata*, in which a fragment consisting of the anal area of the tegmina, from Bellaire, Ohio, is referred to one of the tegmina (without the anal area preserved) from Cassville, W. Va.

FAUNAL LISTS OF AMERICAN PALEOZOIC COCKROACHES.

The enlargement of our vision is, however, not entirely due to the new forms from Cassville and Richmond, but also to the increase in the number of species known from old horizons. Thus the Rhode Island coal field has now furnished a dozen species, including a new genus, while new localities in the Western Interior coal basin have increased their fauna to seven species, and certain additions have been made to other faunas already partially known. The following lists of faunas will prove of interest and show the geographical distribution of the species:

The Western Interior coal field.

Promylacris harei (Mo.).	Etoblattina occidentalis (Kans.).
Paromylacris clintoniana (Mo.).	Anthracoblattina americana (Mo.).
Etoblattina clintoniana (Mo.).	Oryctoblattina laqueata (Mo.).
venusta (Ark.).	

The Eastern Interior coal field (Illinois).

Mylacris elongata.	Paromylacris ampla.
anthracophila.	triangularis.
gurleyi.	Lithomylacris simplex.
ampla.	Archimylacris paucinervis.
antiqua.	Etoblattina mazona.
Promylacris testudo.	hilliana.
ovalis.	Progonoblattina columbiana.
rigida.	Oryctoblattina occidua.
Paromylacris rotunda.	

The Acadian coal field.

Mylacris bretonensis.	Archimylacris acadica.
heeri.	Petrablattina sepulta.

The Rhode Island coal field.

Mylacris packardii.	Etoblattina gorhami.
Microblattina perdita.	exilis.
Etoblattina illustris.	reliqua.
scholfieldi.	latebricola.
clarkii.	Gerablattina scapularis.
sp.	fraterna.

The Appalachian coal field (Pennsylvania).

Mylacris priscovolans.	Lithomylacris pittstoniana.
lucifuga.	pauperata.
carbonum.	Necymylacris lacoana.
pennsylvanica.	heros.
mansfieldi.	Archimylacris parallela.
ovalis.	Etoblattina lesquereuxii.
Paromylacris pluteus.	Gerablattina fascigera.
Lithomylacris angusta.	

The Barren Coal-measures at Richmond, Ohio.

Etoblattina fossa.	Etoblattina hustoni.
strigosa.	hastata.
jeffersoniana.	marginata.
fasciata.	gracilentata.
ramosa.	stipata.
willsiana.	variegata.
maledicta.	Gerablattina apicalis.
benedicta.	richmondiana.
funesta.	minima.
exsensa.	Poroblattina longinqua.
tenuis.	ohioensis.

The Dunkard Creek series at Cassville, W. Va.

Etoblattina lata.	Etoblattina expugnata.
sagittaria.	obatra.
medianata.	imperfecta.
ovata.	secreta.
debilis.	invisa.
balteata.	occulta.
patiens.	defossa.
mucronata.	recidiva.
detecta.	Gerablattina inculta.
exigua.	perita.
residua.	diversinervis.
funeraria.	cassvici.
expuncta.	abdicata.
aperta.	concinna.
eakiniana.	uniformis.
accubita.	permanenta.
expulsata.	permacra.
gratiosa.	eversa.
macerata.	deducta.
immolata.	radiata.
mactata.	lata.
communis.	rotundata.
exsecuta.	ovata.
arcta.	Anthracoblattina virginienensis.
prædulcis.	Poroblattina gratiosa.
angusta.	fossa.
macilenta.	complexinervis.
rogi.	Petrablattina hastata.

TABLES OF DISTRIBUTION OF AMERICAN AND EUROPEAN FOSSIL COCKROACHES.

The following table presents in a summary form the number of species of the different genera of cockroaches found in the American Paleozoic rocks in each of the different coal basins and in the two special localities in Ohio and West Virginia where the greatest number of species have been found. It summarizes the foregoing lists. The horizontal line separates the Mylacridæ and Blattinariæ.

Table showing the geographical distribution of the American Paleozoic genera.

Genera.	Western Interior (Missouri, Arkansas, Kansas).	Eastern Interior (Illinois).	Acadian (Nova Scotia, Cape Breton).	Rhode Island.	Appalachian (Pennsylvania).	Richmond, Ohio.	Cassville, W. Va.	Total.
Mylacris.....		5	2	1	6			14
Promylacris.....	1	3						4
Paromylacris.....	1	3			1			5
Lithomylacris.....		1			3			4
Necymylacris.....					2			2
Microblattina.....				1				1
Archimylacris.....		1	1		1			3
Etoblattina.....	3	2		8	1	17	36	67
Gerablattina.....				2	1	3	15	21
Anthracoblattina.....	1						1	2
Progonoblattina.....		1						1
Oryctoblattina.....	1	1						2
Poroblattina.....						2	3	5
Petrablattina.....			1				1	2
Total.....	7	17	4	12	15	22	56	133

The fact that, with the very considerable increase shown to have been made in the number of known species, hardly a single one of them has been found at two distinct localities, lends importance to the right determination of the horizon at which each species has been found and renders probable, with the further extension of our knowledge of their distribution, the advantageous use of these fossils in delicate discriminations of the age of rock deposits. Accordingly, as a first step in this direction, I have drawn up the succeeding table, showing the relative geological age of each of the American species, the species themselves being arranged systematically, but excluding from the list, as at present unimportant, the three Tertiary species. In this table I have roughly separated the species from the true productive Coal-measures, i.e., above the "Millstone Grit" and below the "Barren Coal-measures," into an upper and lower series, endeavoring as far as possible to make the latter correspond to the coals A-C, inclusive, of the Pennsylvania series, and where the reference was at all doubtful to indicate it in the table by a mark of interrogation instead of the usual cross.

Horizontal distribution of the American pre-Tertiary cockroaches.

Species.	Millstone Grit.	Lower Productive Coal-measures.	Upper Productive Coal-measures.	Barren Coal-measures.	Permian.	Trias.
<i>Mylacris packardii</i>		?				
<i>bretonensis</i>			?			
<i>elongata</i>		x				
<i>anthracophila</i>		x				
<i>gurleyi</i>		x				
<i>ampla</i>		x				
<i>priscovolans</i>		x				
<i>heeri</i>			?			
<i>antiqua</i>		x				
<i>lucifuga</i>			x			
<i>carbonum</i>		x	x			
<i>pennsylvanica</i>		x				
<i>mansfieldi</i>		x				
<i>ovalis</i>		x				
<i>Promylacris harei</i>				x		
<i>testudo</i>		x				
<i>ovalis</i>		x				
<i>rigida</i>		x				
<i>Paromylacris rotunda</i>		x				
<i>ampla</i>		x				
<i>triangularis</i>		x				
<i>clintoniana</i>		x				
<i>pluteus</i>			x			
<i>Lithomylacris angusta</i>			x			
<i>pittstoniana</i>			x			
<i>pauperata</i>			x			
<i>simplex</i>		x				
<i>Necymylacris lacoana</i>		x				
<i>heros</i>		x				
<i>Microblattina perdita</i>		?				
<i>Archimylacris parallela</i>	x					
<i>paucinervis</i>		x				
<i>acadica</i>			x			
<i>Spiloblattina gardineri</i>						x
<i>triassica</i>						x
<i>guttata</i>						x
<i>marginata</i>						x
<i>Etoblattina clintoniana</i>		x				
<i>lata</i>					x	
<i>sagittaria</i>					x	
<i>mediana</i>					x	
<i>fossa</i>				x		
<i>illustris</i>		?				
<i>ovata</i>					x	
<i>scholfieldi</i>		?				
<i>debilis</i>					x	
<i>strigosa</i>				x		
<i>clarkii</i>		?				
<i>venusta</i>	?					
<i>balteata</i>				?	x	
<i>patiens</i>					x	
<i>mucronata</i>					x	
<i>detecta</i>					x	
<i>occidentalis</i>			?			
<i>exigua</i>					x	
<i>sp. (R. I.)</i>		?				
<i>jeffersoniana</i>				x		
<i>residua</i>					x	
<i>funeraria</i>					x	
<i>expuncta</i>					x	
<i>gorhami</i>		?				
<i>aperta</i>					x	
<i>fasciata</i>				x		
<i>ramosa</i>				x		
<i>willsiana</i>				x		
<i>lesquereuxii</i>			x			
<i>maledicta</i>				x		
<i>benedicta</i>				x		
<i>funesta</i>				x		
<i>exsensa</i>				x		
<i>tenuis</i>				x		
<i>hustoni</i>				x		
<i>persistens</i>						x
<i>eakiniana</i>					x	
<i>accubita</i>					x	
<i>mazona</i>		x				

Horizontal distribution of the American pre-Tertiary cockroaches—Continued.

Species.	Millstone Grit.	Lower Productive Coal-measures.	Upper Productive Coal-measures.	Barren Coal-measures.	Permian.	Trias.
<i>Etoiblattina expulsata</i>					X	
<i>gratiosa</i>					X	
<i>macerata</i>					X	
<i>immolata</i>					X	
<i>mactata</i>					X	
<i>communis</i>					X	
<i>sp. (Colo.)</i>						X
<i>hastata</i>				X		
<i>marginata</i>				X		
<i>gracilentata</i>				X		
<i>exsecuta</i>					X	
<i>arcta</i>					X	
<i>stipata</i>				X		
<i>prædulcis</i>					X	
<i>variegata</i>				X		
<i>hilliana</i>		X				
<i>angusta</i>					X	
<i>macilentata</i>					X	
<i>exilis</i>		?				
<i>rogi</i>					X	
<i>expugnata</i>					X	
<i>obatra</i>					X	
<i>imperfecta</i>					X	
<i>secreta</i>					X	
<i>reliqua</i>		?				
<i>invisa</i>					X	
<i>occulta</i>					X	
<i>latebricola</i>		?				
<i>defossa</i>					X	
<i>recidiva</i>					X	
<i>Gerablattina inculta</i>					X	
<i>perita</i>					X	
<i>apicalis</i>				X		
<i>diversinervis</i>					X	
<i>richmondiana</i>				X		
<i>cassvici</i>					X	
<i>abdicata</i>					X	
<i>concinna</i>					X	
<i>uniformis</i>					X	
<i>permanenta</i>					X	
<i>permacra</i>					X	
<i>eversa</i>					X	
<i>deducta</i>					X	
<i>scapularis</i>		?				
<i>fraterna</i>		?				
<i>radiata</i>					X	
<i>lata</i>					X	
<i>rotundata</i>					X	
<i>ovata</i>					X	
<i>minima</i>				X		
<i>fascigera</i>	X					
<i>Anthracoblattina americana</i>		X				
<i>virginiensis</i>					X	
<i>Progonoblattina columbiana</i>		X				
<i>Oryctoblattina occidua</i>		X				
<i>laqueata</i>				X		
<i>Poroblattina longinqua</i>				X		
<i>gratiosa</i>					X	
<i>fossa</i>					X	
<i>meieri</i>						X
<i>arcuata</i>						X
<i>lakesii</i>						X
<i>ohioensis</i>				X		
<i>complexinervis</i>					X	
<i>Petrablattina sepulta</i>		X				
<i>hastata</i>					X	
<i>æqua</i>						X
<i>Neorthroblattina albolineata</i>						X
<i>lakesii</i>						X
<i>rotundata</i>						X
<i>attenuata</i>						X
<i>Scutinoblattina brongniarti</i>						X
<i>intermedia</i>						X
<i>recta</i>						X

With this may be compared the next table, in which I attempt a similar division of the described European species, separating them by the zones employed by Dr. H. B. Geinitz in his *Steinkohlen Deutschlands* (1865), his Zone I (which does not come into use here, and which I take to be the equivalent of our Millstone Grit), being the "Hauptzone der Lycopodiaceen;" II, "der Sigillarien;" III, "der Calamiten;" IV, "der Annularien;" V, "der Farren;" succeeded by the Dyas or Permian. I have been aided by Kliver's tabulation of the species found in the Saarbrück basin (*Palæontographica*, XXIX, 264-265), whose separation of the "upper" and "middle" coal formation falls, Dr. Geinitz informs me, near the middle of Zone IV. The Löbejün basin, he tells me, belongs by its sigillarians to the middle coal formation, but is at the same time scarcely separable from that of Wettin, which on its part closely agrees with that of Manebach, etc., and must be regarded as of the upper coal formation. In the following table I have placed all of the species from Löbejün and Wettin in Zone IV, and those of Manebach in Zone V, but classed them both as of the upper coal formation.

Horizontal distribution of the European Paleozoic cockroaches.

Middle Carboniferous.		Upper Carboniferous.		Dyas.
Zone II.	Zone III.	Zone IV.	Zone V.	
Etobl. bituminosa. mantidioides. ¹ johnsoni. ¹ deanensis. ¹ steinbachensis. ²	Etobl. primæva.	Etobl. didyma. ³ affinis. ³ anaglyptica. ³ carbonaria. ³ dohrnii. ³ flabellata. ³ euglyptica. ³ leptophlebica. ³ parvula. ³ russoma. ³ propria. lanceolata. ³ Gerabl. geinitzi. ³ germari. ³ münsteri. ³ producta. ³ Anthracobl. wagneri. ³ spectabilis. ³ Oryctobl. arndti. ³ reticulata. ³	Etobl. didyma. intermedia. labachensis. manebachensis. Gerabl. clathrata. goldenbergi. mahri. weissiana. robusta. Anthracobl. remigii. dresdensis. scudderi. Hermatobl. kirkbyi. ⁴ wemmetzweileriensis. Progonobl. fritschii.	Etobl. elongata. weissigensis. dyadica. stalzneri. deichmülleri. flabellata. ornatissima. Gerabl. rollei. Anthracobl. porrecta. spectabilis? rückerti. sopita. Hermatobl. lebachensis. Oryctobl. oblonga. Petrabl. gracilis.
Gerabl. scaberata. Anthracobl. incerta. winteriana. camerata. lubnensis. Progonobl. helvetica. ¹ Leptobl. insignis. exilis. ¹				

¹ Certainly belonging to the Middle Carboniferous and probably to Zone II.² Placed here by presumption only; it may belong to the Upper Carboniferous.³ Belonging to the Upper Carboniferous and probably to Zone IV.⁴ Credited to the Upper Carboniferous, but perhaps belonging in Zone IV.

Finally, the following table may be of interest, in which a provisional attempt is made to correlate in a summary way the details of the foregoing tables. It indicates merely the presence of the different genera of fossil cockroaches in the several periods from which they are known, whether in Europe (by the letter E in the horizons in which they occur) or in America (by the letter A). It includes all the known described Palæoblattariæ of the world, with the addition of the fossil Neoblattariæ of North America only. The numerous Liassic forms of Europe are therefore omitted. For convenience the Mylacridæ are separated by a horizontal line from the Blattinariæ, and the Neoblattariæ from the Palæoblattariæ.

Geological distribution of the genera of fossil cockroaches.

Genera.	Millstone Grit.	Lower Productive Coal-measures.	Higher Productive Coal-measures.	Barren Coal-measures.	Permian.	Trias.	Tertiary.	Present epoch.
Mylacris.....		A	A					
Promylacris.....		A		A				
Paromylacris.....		A	A					
Lithomylacris.....		A	A					
Necymylacris.....		A						
Microblattina.....		A						
Archimylacris.....	A	A						
Spiloblattina.....						A		
Etoblattina.....	A ¹	A E	A	A E	A E	A		
Gerablattina.....	A	A E		A E	A E			
Anthracoblattina.....		A E		E	A E			
Hermatoblattina.....				E	E			
Progonoblattina.....		A E		E				
Oryctoblattina.....		A	E	A	E			
Poroblattina.....				A	A	A		
Petrablattina.....		A			A E	A		
Leptoblattina.....		E						
Neorthroblattina.....						A		
Scutinoblattina.....						A		
Zetobora.....							A	A
Homoeogamia.....							A	A
Paralatindia.....							A	A

¹ Subject to correction as noted on pp. 60, 73.

THE RAPID INCREASE IN OUR KNOWLEDGE.

The relative increase of our knowledge of the Paleozoic cockroaches of Europe and America can best be shown by the following table, in which the number of species of each genus on each continent, as shown

in my first work on the subject and at the present time, are placed in separate columns:

Genera.	Europe.		America.		Total.	
	1879.	1893.	1879.	1893.	1879.	1893.
<i>Mylacris</i>	0	0	5	14	5	14
<i>Promylacris</i>	0	0	0	4	0	4
<i>Paromylacris</i>	0	0	0	5	0	5
<i>Lithomylacris</i>	0	0	3	4	3	4
<i>Necomylacris</i>	0	0	2	2	2	2
<i>Microblattina</i>	0	0	0	1	0	1
<i>Archimylacris</i>	0	0	2	3	2	3
<i>Etoblattina</i>	18	27	2	67	20	94
<i>Gerablattina</i>	10	11	2	21	12	32
<i>Anthracoblattina</i>	7	11	0	2	7	13
<i>Hermatoblattina</i>	2	3	0	0	2	3
<i>Progonoblattina</i>	2	2	0	1	2	3
<i>Oryctoblattina</i>	1	3	0	2	1	5
<i>Poroblattina</i>	0	0	0	5	0	5
<i>Petrablattina</i>	1	1	1	2	2	3
<i>Leptoblattina</i>	0	2	0	0	0	2
Total	41	60	17	133	58	193

While the total number of species has thus more than trebled, the European species have increased about 50 per cent while the American species have multiplied nearly eightfold. It should not be overlooked, however, that a very different result would unquestionably appear if the Commentry cockroaches, which Brongniart announced in 1889 had then been found to the number of more than 600, had been published. Unfortunately not a single one has yet been described.

This table shows also the genera which are known from Europe and America and permits a ready comparison between the representation of the genera on the two continents. It shows that in each *Etoblattina* and *Gerablattina* easily hold the first place and that *Etoblattina* is especially rich in forms, containing just about one-half the species of either continent. It also makes conspicuous a point to which I called attention in my first essay on Paleozoic cockroaches—that the Mylacridæ, comprising nearly 22 per cent of the species and five of the fourteen genera in America, are, so far as described forms are concerned, completely absent from Europe.

SOME CHARACTERISTICS OF MYLACRIDÆ.

This, however, it appears, is not a statement of the actual fact; for, in a brief note on Carboniferous cockroaches published in the *Comptes rendus* of the French Academy for February 4, 1889, Mr. Charles Brongniart states that Mylacridæ are as abundant as Blattinariæ at the famous locality at Commentry, France, although the latter only have hitherto been found fossil in other places in the European Coal-measures. Brongniart gives neither description nor figures in support of this statement, but points out from the uncommonly well-preserved specimens found at Commentry what he regards as further points of distinction between the Mylacridæ and Blattinariæ, drawn from the structure of the thorax: the prothoracic shield of the Blattinariæ being

well rounded and narrower than the body including the folded wings, while that of the Mylacridæ is broader than the stout body, and, instead of being rounded, is nearly in the form of a triangle, its base forward.

These distinctions can not be maintained for the American forms. Although specimens of either group showing anything more than the tegmina are rare in the American rocks, a few have been found and have been published, while still others are made known in the present paper. In no case do those show a prothorax wider than the folded wings, although in some, notably in *Promylacris testudo*, the prothorax is nearly as wide; nor in any of the Mylacridæ, where a subtriangular form is more common than in the Blattiniæ, is the broadest portion in advance of the middle, as must be the case if in the form of a triangle its base forward (il a presque la forme d'un triangle à base située en avant), but always behind it.

Stated broadly, the Mylacridæ are usually stouter bodied than the Blattiniæ (though the species of *Lithomylacris* are usually as slender as most Blattiniæ), and the prothoracic shield is usually, but not always, broader in proportion to its length in the Mylacridæ and is not unfrequently subtriangular, by the subangular projection of the middle of the front border, and of the extreme sides of the posterior margin. An excellent illustration of this is seen in *Paromylacris rotunda* and in *Promylacris rigida* (Pl. III, fig. 1), in which latter the form of the prothorax is very different from the transverse suboval of its congener *P. testudo*. A publication of the different forms of Mylacridæ alleged to be found at Commentry is therefore all the more to be desired, and it is much to be hoped that Mr. Brongniart will favor the world at an early day with further and fuller details regarding the superb collections in his hands. They can not fail to throw much light upon our knowledge of the earlier insects. The only specimens I have myself seen from Commentry (a photograph and a very perfect fore wing) are *Etblattinæ*.

Before proceeding to the special description of the new American forms, there are a few matters which I will consider under separate heads, as follows:

1. The relative size of ancient cockroaches.
2. The features of a nearly complete body of a Carboniferous cockroach from Illinois.
3. The hind wings of Paleozoic cockroaches.
4. Possible mimicry in Paleozoic cockroaches.
5. The European species of *Etblattina*, with description of a new form.
6. A list of the described European Paleozoic cockroaches.
7. The terminology of the neurulation.

I. THE RELATIVE SIZE OF ANCIENT COCKROACHES.

No one can handle many Paleozoic cockroaches without being struck by the fact that they are of large size. I drew attention to this in my *Paleozoic Cockroaches*, remarking that "while the average was considerably above that of existing cockroaches, none were much larger than some South American species of *Blabera*," whose tegmina sometimes attain a length of 60 to 70 mm. But in the present paper a fragment of a fore wing is described, which, when perfect, must have measured 80 mm. in length. In an estimate from the then known species of Paleozoic cockroaches, I stated that "the average length of the front wing appears to have been about 26 mm."

Since then the increase in the number of species in this country has been largely from the younger Paleozoic rocks, and if we were to add the Triassic *Palæoblattariæ*, of still smaller size, we should find that the average length of the fore wing in ancient American cockroaches, 133 species in all, was 23.2 mm. The *Mylacridæ* were larger, on the average, than the *Blattinariæ*, a fact due in great part to the younger cockroaches being all *Blattinariæ*, for the tegmina of 29 *Mylacridæ* average 27.5 mm., while those of 104 *Blattinariæ* average 22 mm. only. That even this last figure is larger than the average size of living cockroaches, one familiar with the latter would readily venture to assert; but to put it to a fair test, I have estimated the average size of recent species from the measurements given in Brunner's *Système des Blattaires* (1865), the last general work on the subject. About 380 species are included in this work, but of only 239 are measurements given of the length of the tegmina; where different measurements are given for the two sexes I have uniformly chosen that for the male as in general the larger; and where the measurements covered a range I have taken the exact mean. In this way I estimate the average length of the tegmina of living cockroaches to be 18.8 mm., which is markedly less than the size of the Paleozoic forms.¹

This, however, is by no means the whole of the story. I have further tabulated separately the length of the tegmina for the different American species from the Millstone Grit to the Trias, inclusive, and find that there is a marked and regular diminution in average size from one period to another, as will appear from the following measurements of the tegmina given in millimetres:

Millstone Grit (3 species), 26 to 38, average 31.

Lower Productive Coal-measures (39 species), 10 to 61, average 29.7.

Upper Productive Coal-measures (12 species), 16.35 to 33, average 26.4.

Barren Coal-measures (23 species), 9.75 to 31.5, average 23.4.

Permian (56 species), 8.25 to 28.75, average 16.9.

Trias (17 species), 6.3 to 24, average 13.

¹In making this estimate, though I recollected I had once made one of the same nature, I had forgotten its publication, and only after the above was written discovered it in my *Revision of Mesozoic Cockroaches*, where a slightly different result follows slightly different data; but I prefer to leave the above as it stands.

The only important doubt about the exact accuracy of this statement is that the fauna of the Rhode Island coal basin (consisting of 12 species) is included in the Lower, when it may perhaps belong to the Upper Productive Coal-measures. The average size of the Rhode Island species is 27.3 mm., and that of the species from the Lower Productive Coal-measures without them is 30.7 mm., while, if the Rhode Island species were added to the Upper series, it would increase the average of that to 26.8 mm.; but this would still not disturb the regular succession of averages. The average size of the 50 species from the Productive Coal-measures as a whole is 27.4 mm., or almost precisely that of the Rhode Island species alone.

I do not mean to maintain that the size of cockroaches has been steadily and continuously diminishing from the earliest times to the present, but only for that period of time which is here considered, and also, I may add, for the later Mesozoic rocks, for I have formerly shown that the average length of the tegmina of European Mesozoic (mostly Liassic) cockroaches was 12.5 mm., which is slightly less than that of the species from the American Trias. It is well known that the great mass of Mesozoic, and especially Liassic, insects were of small size, but the insects of the Tertiaries did not differ in this respect in any noticeable degree from those now living.

I have further tabulated the relative length of the tegmina in the different genera separately, both as a whole and in each of the periods in which they occur. They may be shown as follows, the figures being given in millimeters, and showing both range and average:

Average length of tegmina in the genera of American fossil cockroaches.

Genera.	Mill-stone Grit.	Lower Productive Coal-measures.	Upper Productive Coal-measures.	Barren Coal-measures.	Permian.	Trias.	In all.
Mylacris		26.50-42.00 Aver. 31.10	16.35-33.00 Aver. 25-60				16.35-42.00 Aver. 28.50
Promylacris		19.00-29.00 Aver. 25.30		17.50			17.50-29.00 Aver. 21.70
Paromylacris		21.00-42.00 Aver. 28.50	30.00				21.00-42.00 Aver. 26.60
Lithomylacris		24.00	26.00-29.25 Aver. 27.20				24.00-29.25 Aver. 26.40
Necymylacris		25.00-48.00 Aver. 36.50					25.00-48.00 Aver. 36.50
Microblattina		8.00					8.00
Archimylacris	26.00	26.00-30.50 Aver. 28.25	23.00				23.00-30.50 Aver. 26.50
Spiloblattina						15.00-18.00 Aver. 16.40	15.00-18.00 Aver. 16.40
Etoblattina	29.00	14.25-61.00 Aver. 26.40	25.00-32.00 Aver. 28.50	14.00-31.00 Aver. 25.50	11.75-28.75 Aver. 17.60	12.00-20.00 Aver. 16.00	11.75-61.00 Aver. 21.30
Gerablattina	38.00	18.00-41.00 Aver. 29.50		9.75-25.00 Aver. 18.30	10.00-25.50 Aver. 16.60		9.75-41.00 Aver. 19.10
Anthracoblattina		30.00			12.00		12.00-30.00 Aver. 21.00
Progonoblattina		20.75					20.75
Oryctoblattina		19.00		21.00			19.00-21.00 Aver. 20.00
Poroblattina				11.00-22.00 Aver. 16.50	13.50-16.75 Aver. 15.60	10.00-19.00 Aver. 13.70	10.00-22.00 Aver. 15.10
Petrablattina		13.00			8.25	24.00	8.25-24.00 Aver. 15.10
Neorthroblattina						8.50-12.00 Aver. 9.60	8.50-12.00 Aver. 9.60
Scutinoblattina						6.30-7.00 Aver. 6.80	6.30-7.00 Aver. 6.80

This table shows that in general, especially where the species were numerous, the same rule holds remarkably under each genus, the average size decreasing with the lapse of time. The only noticeable exception is in the two divisions of the Productive Coal-measures, where, in the genera *Paromylacris*, *Lithomylacris*, and *Etoblattina*, the averages are reversed from what they should be under the rule. The other exceptions, as in *Oryctoblattina*, and in part in *Petrablattina*, and in *Archimylacris*, are where only a couple of species or so are concerned. The relative average size of the species of the different genera is also shown, and proves that the average size of every genus of *Mylacridæ* is larger than that of any of the other genera excepting only *Archimylacris*, which, as I have elsewhere pointed out, was the most antique type of all cockroaches. The table further lends support to the view that the Dunkard Creek series of rocks (at Cassville) are older than the Barren Coal-measures, and should be referred to the Permian, since in each of the three genera represented in both beds the average size of the species from the Dunkard Creek series is the smaller.

II. THE BODY OF A PALEOZOIC COCKROACH.

Pl. XII, figs. 8-11.

Through the kindness of Prof. Josua Lindahl, of the Illinois Museum of Natural History, I have been permitted twice to examine a very curious specimen, which I regard as the principal part of the body of a wingless cockroach from the Coal-measures of Illinois. It is entirely freed from the matrix, and, with the exception of the head and appendages of the body, represents the complete body of a cockroach, probably in very much of its original form. The proportions of the abdomen indicate that it was in all probability a female, but whether a larval form or a mature individual with the wings removed is quite impossible to say. If a female, the ovipositor, said by Brongniart to be characteristic of Paleozoic cockroaches, is broken away. Fig. 9 is presumed to represent the ventral and fig. 11 the dorsal aspect of the creature, partly from the form of the upper surface of the metathorax, as shown particularly in fig. 10, and from the fact that there are what are apparently scars at the position of the mesothoracic coxæ on the ventral surface, which, however, do not clearly appear in the figure. The abdomen is composed of eight complete segments, similar dorsally and ventrally, as may best be seen by fig. 10. The first segment encircles the whole body externally, and is not covered at the sides by the projecting margins of the metathorax, as in modern cockroaches. There are, however, several anomalies in the abdomen and difficulties to be explained. Fig. 11 represents the dorsal aspect with the only clear indications, as shown also in fig. 10, of the separation of the mesothorax and metathorax, but with a distinct indication throughout of the first abdominal segment, which scarcely shows on the ventral aspect (fig. 9),

and the difference in the separation of which from the metathorax on the dorsal and ventral surfaces is clearly shown in fig. 8. The second and seventh abdominal segments are the only ones which are clearly distinct upon both margins throughout the entire circuit of the body, as shown in all the figures. The third and fourth segments are clearly distinct on the dorsal surface, but on the ventral (fig. 9) the distinction between the third and fourth is lost, excepting on the right, where it is as distinct as above; possibly the remaining portion of the third segment may be broken away. Dorsally, the fifth segment is traversed by an oblique fold, which does not appear elsewhere, and makes an apparent separation of the segment into two subsegments. Similar indications, which only traverse a portion of the body, elsewhere appear, and the relation of the other parts to one another renders it clear that there is here no true subsegmentation. The apparent division of the eighth segment in fig. 10 is explained by the other figures, which show that this segment is made up in the original of a bundle of irregular bosses which may have terminated (as Brongniart describes for the better preserved specimens of fossil cockroaches from the Coal-measures of Commentry, France) with a long ovipositor, similar to those of our living Phasmidæ.

The abdomen is thus seen to differ from that of modern cockroaches in being composed of eight complete and tolerably uniform rings with no distinct separation, as may best be seen in fig. 10, into dorsal and ventral scutes, and in consequence there are as many ventral as dorsal, excepting only that the first segment is separated from the metathorax distinctly only on the dorsal surface, as is best seen in fig. 8. This may be the first step in a distinction between the dorsal and ventral surfaces as seen in modern cockroaches. But there is a further indication of something similar in the fold upon the dorsal surface of the fourth abdominal segment, indicating a division into subsegments at this point. In this case, however, the difference between the dorsal and ventral surfaces would appear to result from a division of one of the dorsal scutes rather than from a suppression of one of the ventral.

As it is impossible to determine to what genus this fragment may have belonged, or even to what family of ancient cockroaches, no name is given to it at present. It was obtained at Olney, Ill., by Mr. B. E. Phillips, and was presented by him to the Illinois Museum of Natural History, where it bears the number 4941.

III. THE HIND WINGS OF PALEOZOIC COCKROACHES.

Pl. XII, figs. 4-7.

By far the larger part of the remains of fossil cockroaches consist of the tegmina, but in a few instances the hind wings have been preserved, sometimes by themselves, sometimes in connection with the tegmina; and, as a few additional forms are illustrated in the present paper, it may be well to draw general attention to them more carefully than has yet been done.

On previous occasions I have mentioned the undoubted fact that the fore and hind wings of Paleozoic insects harmonized in neuration more completely than they do in living insects, and have also stated that even differentiation in texture, such as exists to-day in many groups (especially the lower), had scarcely begun, the neuration being always equally apparent in both wings. That this latter statement is not absolutely true for Paleozoic insects, that their fore wings were of somewhat denser texture or tougher consistency than the hind pair, must, I think, be conceded, when we note how extremely rarely the hind wings are preserved, as compared with the fore wings; nevertheless, when they are preserved, no such difference is discernible.

How rarely the hind wings of Paleozoic cockroaches are known may be quickly made apparent by the statement that up to the present time they have been figured for only three European species, two of *Etblattina* and one of an undetermined form (*Blattina latinervis*) and for five American, namely, one species each of *Promylacris*, *Paromylacris*, *Archimylacris*, *Oryctoblattina*, and *Etblattina*, to which are added in the present paper one each of *Mylacris* and *Etblattina*, and two others of independent wings, one of which may be referred to *Etblattina*, while the other, though nearly perfect, is very problematical. Those which are preserved in connection with other parts rarely show much beside the apical third, so that our knowledge of them is less advanced than it ought to be when they are thus so much more readily determinable. From this meager showing the following statements may be made, though they are offered with some hesitation, from the fragmentary material on which they are based:

It seems probable from the general harmony between the fore wings and the hind pair that a difference somewhat similar to that which exists between the fore wings of *Mylacridæ* and *Blattinariæ* will be found in the hind wings. In no case, however, have we yet found the costal margin of the hind wing preserved in any of the *Mylacridæ*; but in several of the *Blattinariæ* we see the mediastinal area stretching as a very narrow vittate field much more than half way to the apex of the wing, much narrower than is usual in the fore wing; while analogy would lead us to infer that in the *Mylacridæ* it was relatively much shorter and perhaps to a greater or less degree triangular. This is my sole reason for believing it probable that the wing figured on Pl. XII,

fig. 5, is one of the *Blattinariae*, to which is opposed the close resemblance it bears, in parts which allow of any comparison at all, to *Promylacris*, its excessive size, and the general composition of the fauna from which it comes, as will be stated later in the special description of this wing.

As a general rule the internomedian area, on the contrary, appears to have been broader than in the tegmina, and did not possess the special character of distinction from the mode of branching in the other areas which it had in the fore wing. In the latter, for instance, the branches of this area are generally much more delicate than in the other areas, and are usually more widely separated and very uniform. In all the hind wings where this area is preserved the branches are in no way more delicate than those of the other areas, while, with the exception of *Mylacris*, the branches are as close as elsewhere, and usually somewhat or considerably irregular. Curiously, in *Mylacris* the general appearance of this area is precisely as in the fore wing, differing apparently only in being narrower and tapering less rapidly. The other intermediate areas of the hind wing differ from their general character in the fore wing in having the branches more of an arborescent type, in which it is difficult to say what course the main vein with its irregular or regular breaking up takes, or on which side, if not on both, the principal branches are thrown off from the main stem. In general the division of the scapular and externomedian areas on the border is at or close to the apex of the wing, which seems always to lie, not at the end of the middle line of the wing, but somewhere in its upper half, so that the wing is less symmetrical in form than the fore wing.

Whether we shall ever be able to determine the characteristics of different genera in the hind wings may be deemed doubtful; certainly not until a vast deal more is known about them than now. Possibly when the rich *Blattarian* fauna of Commeny has undergone the investigation it awaits at the hands of Mr. Charles Brongniart, we shall be able to speak more hopefully, but at present the genus *Etoblattina* is the only one of which we have representatives of more than a single species.

In *Etoblattina* the hind wing is pointed-ovate, broadest beyond the middle, fully twice as long as broad, with very straight costa until the wing begins to narrow, and with a very full and rounded inner border, the apex being not far from the middle of the upper half of the wing. The mediastinal area is very narrow and reaches to the middle of the apical half of the wing or farther, with arcuate, very oblique branches. The scapular vein is very straight, throws off very oblique forking branches to the costal margin, first forking a little before the middle of the wing, and terminates at or above the apex. The externomedian vein is likewise straight, first branches as soon as or a little before the scapular, the branches forked or generally compound, rarely simple, and nearly or quite longitudinal; they seem to be indifferently inferior

or superior, but all either one or the other. The internomedian area is very broad, generally occupying fully half the breadth of the wing in its basal half, the main vein straight or nearly straight, running obliquely to the inner margin of the wing and ending just about as far toward the apex as the mediastinal vein; the branches are all inferior, closely crowded, nearly straight and oblique, and generally simple. Of the anal area nothing can be known from present specimens, excepting what is seen in the specimen figured on Pl. XII, figs. 6, 7, which will be mentioned in its description, later in this paper.

An exception to these characters is so great in a hind wing, which I have recently figured¹ and called an *Etoblattina*, that I am now inclined to think it can not belong to this genus, but perhaps to *Gerablattina*, also found in the same beds. It is again figured here in Pl. XII, fig. 4. These exceptions consist in the form of the wing, in which the apex (which is destroyed) apparently must fall about the middle of the wing, while the inner border is much less full; in the earlier forking of both scapular and externomedian veins, the former earlier than the latter; the more arborescent or apical branching of the externomedian vein, the branches of which are both superior and inferior, and in the different character of the internomedian area, which is by no means so broad as in all the *Etoblattinae* known, and has only a few branching, very oblique veins. The anal area is here preserved, and is remarkable as being but a shorter form of the mediastinal type.

The hind wing of *Archimylacris*, so far as we know it, is again somewhat different. The form would appear to be the same as in *Etoblattina* and the mediastinal area similar but much longer. The scapular vein, however, is very different, and the few branches are distant, inferior, and include the apex at the margin, extending, indeed, farther below the apex than above it. The externomedian vein appears to be a repetition on a lesser scale of the scapular, but more can not be said.

The peculiar character of the internomedian area in *Mylacris* has already been mentioned. All that can be further said of the hind wing in this genus is that the externomedian vein (excepting that the branches are superior and not inferior) appears to be a repetition of the same area in the fore wing and to bear a similar relation to the internomedian area.

In *Paromylacris* the scapular and externomedian areas appear to be extremely similar to their condition in *Etoblattina*, the division line between them also falling at just about the pointed apex of the wing, which, so far as can be seen, has a similar form.

Probably the same is also true of *Promylacris*, though this is entirely uncertain from the slight fragment of the apex which is preserved, for, on the contrary, it may be entirely similar to the wings figured on Pl. XII, fig. 5.

¹ Bull. U. S. Geol. Surv., No. 101, pl. 2, Fig. k.

IV. POSSIBLE MIMICRY IN PALEOZOIC COCKROACHES.

Before finishing these introductory remarks I wish to draw attention to a topic unusual in such a connection. In studying protective resemblance and mimicry among living animals, the exceedingly common occurrence of these phenomena has often forced upon me the conclusion that they have not been limited in their scope to recent times, but must have existed in past epochs and even, to some extent at least, in very remote epochs. This is a natural conclusion from the universality of their present occurrence. Hardly an animal exists that does not actually owe its existence to some feature or features in its form or coloring. This statement will doubtless appear strong to those who are unacquainted with or have not considered the facts. Let me reenforce it in the words of its latest exponent, M. Félix Plateau, the well-known professor in the University of Gand:

The thesis I wish to sustain, in agreement with naturalists of high merit, would demonstrate that the phenomena [of mimicry] are general; that is to say, that there are hardly any animals which, in at least some one of the stages of their existence, do not have recourse to imitation; that in our own countries, in temperate Europe, in Belgium itself, the zoologist who is really an observer meets at every step cases of dissimulation which are every whit as striking as [ne le cédent en rien] those which tropical nature offers us.¹

The arguments I have used in my own essay on the subject² attempt to show that in the very nature of things protective resemblance must prevail in a world where creatures are the food of others, and where they escape destruction only when less easily or less frequently seen by their predaceous foes than their fellows. From this standpoint it would be difficult to refrain from the logical conclusion that protective resemblance was nearly or quite as much a feature of past life as it is of present.

Naturally, since coloring forms the most important or the most common part of protection, proof of such protection can not be derived from the fossils. But pattern of markings is also a conspicuous element of protection in existing types, and in a few fossils among insects we can detect markings of a precisely similar nature to some which in existing insects can be proved protective; but here habit and association are often necessary factors, and these can usually only be inferred in the extinct types, but inferred in some instances with considerable reasonableness. The examples which I have in mind are all drawn from Tertiary faunas; but I refer to the matter here since it seems to me fairly reasonable to look upon some forms of Carboniferous cockroaches as probably imitative and thereby protective. The first cockroach wing ever described was first described as a fern leaf, and in all or nearly all the localities where their remains have been found they are associated with fern-leaves in immense abundance. While searching for

¹ Bull. Acad. Roy. Belg. (3), XXIII, 92 [1892].

² Atlantic Monthly, Feb., 1889; Butt. east. U. S. and Canada, 710-720.

their remains in the Permian deposits at Cassville I was much struck by this resemblance and was repeatedly obliged to use the glass to determine whether it was the wing of a cockroach or the frond of a fern I had uncovered, and the instances are not rare where they agree completely in size. The general distribution of the nervures is to cursory view the same in each, and the form is often nearly identical. Only the differentiation of the anal area in the cockroach wing at once distin-



FIG. 1.—*Gera-blattina permianenta*.



FIG. 2.—One of the pinnae of *Neuropteris odontopteroides*.

guishes them, but this is really a feeble point and would often be noticed only by an expert. To show how close the general resemblance is I place here side by side figures of a cockroach wing and a fern frond found associated in the same beds¹ and ask whether it is not plausible to suppose that the intimacy of the resemblance is due, as such an instance of associated organisms would now be regarded if the color agreed, to the action of selection in producing protective resemblance. The ordinary color of the tegmina of existing cockroaches is brown or testaceous, yet there are not wanting numer-

ous examples, at least in the tropics, where they are as green as the leaves of ordinary vegetation.

V. THE EUROPEAN SPECIES OF ETOBLATTINA, WITH DESCRIPTION OF A NEW FORM.

For the convenience of students a first essay is here made to tabulate the European species of Etoblattina, the genus of cockroaches most numerous represented in Carboniferous times, both in Europe and America. All the species described up to the present time are introduced, together with a new British species, a description of which is added. It will be seen that Deichmüller's var. *stelzneri* (regarded by him as a form of *E. flabellata*), and Geinitz's var. *dyadica* (regarded by him as another form of the same), are considered distinct species; and that *E. rollei* Deichm. is not included, this last being more probably a Gerablattina. *E. peachii* Woodw. is also omitted, as the tegmina are undeveloped, and therefore present no features which could admit it into the table. On the other hand, *Blattina intermedia* Gold., formerly described by me as a Gerablattina, has had new light thrown upon it by Kliver, showing it to be an Etoblattina, and it is accordingly introduced here.

¹Specimens showing far closer resemblance could easily be selected, but the time at my disposal when the illustration was needed did not admit of a better choice. The plant is from the roof shales of the Waynesburg coal, above the "roof coal" at Cassville and is copied from one of the figures in Fontaine and White's Permian Flora (Rep. Penn. Geol. Surv., PP). The insect comes from the shales which separate the "roof coal" from the main coal beneath, at the same locality.

Table of the European species of Ectoblattina.

- a*¹. Tegmina broad, at most but little more than twice as long as broad, the mediastinal area usually broad at base, here generally occupying a third or more of the tegmina.
- b*¹. Mediastinal area tapering gradually, and relatively long, more, often much more, than four times as long as greatest breadth.
- c*¹. Relatively slender, the tegmina distinctly more than twice as long as broad.
- d*¹. Apical margin divided between the scapular and externomedian areas.
1. *E. labachensis*.
- d*². Apical margin divided between the externomedian and internomedian areas 2. *E. intermedia*.
- c*². Tegmina broad, not more than twice as long as broad, the immediate apex occupied by the externomedian branches.
- d*¹. Tegmina less than twice as long as broad; mediastinal area reaching nearly to the middle of the distal half of the tegmina; externomedian vein first forking not before the middle of the tegmina 3. *E. propria*.
- d*². Tegmina twice as long as broad; mediastinal area hardly extending beyond the middle of the tegmina; externomedian vein first branching far before the middle of the tegmina 4. *E. deichmülleri*.
- b*². Mediastinal area tapering rapidly and relatively short, less, often much less, than four times as long as basal breadth.
- c*¹. Internomedian area long and numerous branches, falling but little short of the apex of the tegmina.
- d*¹. Humeral angle prominent, the tegmina less than twice as long as broad.
5. *E. steinbachensis*.
- d*². Humeral angle roundly excised, the tegmina more than twice as long as broad 6. *E. primava*.
- c*². Internomedian area relatively short and with few branches, falling far short of the apex of the tegmina.
- d*¹. Mediastinal vein with frequent branches; scapular branches few, mostly forked deeply or compound 7. *E. deanensis*.
- d*². Mediastinal vein with infrequent branches; scapular branches numerous, mostly simple or only apically forked 8. *E. lanceolata*.
- a*². Tegmina relatively slender, rarely less than two and a half times as long as broad, the mediastinal area usually rather slender and ribbon-shaped, not or scarcely broader at base than in the middle, and rarely occupying more than a fourth of the basal width of the tegmina.
- b*¹. Tegmina distinctly less than three times as long as broad.
- c*¹. Internomedian area long but far from attaining the apex of the tegmina, rarely prolonged by distinct sinuosity of the main vein.¹
- d*¹. Mediastinal area extending well beyond the middle of the tegmina.
- e*¹. Externomedian vein first branching beyond the middle of the tegmina.
9. *E. carbonaria*.
- e*². Externomedian vein first branching far before the middle of the tegmina.
- f*¹. Tegmina of large or medium size, well rounded at apex; externomedian area expanded and on the margin as important as the scapular.
- g*¹. First scapular branch arising far before the succeeding, near the middle of the basal half of the tegmina; internomedian vein scarcely sinuate 10. *E. russoma*

¹This is only conjectural in *E. mantidioides*, but indicated by the parts preserved.

Table of the European species of Etoblattina—Continued.

- g*². First scapular branch arising but little before the middle of the tegmina and at ordinary distance before the succeeding; internomedian vein strongly sinuate 11. *E. dyadica*.
- f*². Tegmina of small size, subacuminate at apex; externomedian area compressed and on margin of much less importance than the scapular..... 12. *E. parvula*.
- d*². Mediastinal area scarcely if at all surpassing the middle of the tegmina.¹
- e*¹. Scapular and externomedian veins first branching at nearly the same point.²
- f*¹. Primary offshoots of the externomedian vein numerous.
- g*¹. Course of the externo-internomedian interspace gently oblique, arcuate..... 13. *E. manebachensis*.
- g*². Course of the externo-internomedian interspace strongly oblique, sinuous..... 14. *E. ornatissima*.
- f*². Primary offshoots of the externomedian vein only two or three in number 15. *E. anthracophila*.
- e*². First branching of the externomedian vein far beyond that of the scapular 16. *E. mantidioides*.
- c*². Internomedian area very long, nearly reaching the apex, or reaching the apical margin, often prolonged by distinct sinuosity of the main vein.
- d*¹. Mediastinal area extending well beyond the middle of the tegmina.
- e*¹. Scapular vein first branching far beyond the middle of the tegmina. 17. *E. johnsoni*.
- e*². Scapular vein first branching before, often far before, the middle of the tegmina.
- f*¹. All the internomedian branches simple or simply forked.
- g*¹. Scapular vein first branching at some distance before the externomedian 18. *E. dohrnii*.
- g*². Scapular vein first branching but little before the externomedian.
- h*¹. Mediastinal and scapular branches with normal obliquity; internomedian branches frequent, with normal obliquity. 19. *E. didyma*.
- k*². Mediastinal and scapular branches very longitudinally oblique; internomedian branches exceedingly few and longitudinally oblique..... 20. *E. bituminosa*.
- f*². Some apical branches of the internomedian vein compound. 21. *E. anaglyptica*.
- d*². Mediastinal area hardly reaching the middle of the tegmina.
- e*¹. Scapular vein in the middle of its course receding from the margin to reach the middle line of the tegmina..... 22. *E. leptophlebica*.
- e*². Scapular vein in the middle of its course hardly receding from the margin and nowhere nearly reaching the middle line of the tegmina 23. *E. flabellata*.
- b*². Tegmina distinctly more than three times as long as broad; internomedian area long and slender.
- c*¹. Internomedian area not nearly reaching the apex of the tegmina, with no extension by the distal sinuosity of the main vein.
- d*¹. Tegmina less than 20 mm. long; course of the main scapular vein distinctly sinuous, and at one point nearly reaching the middle line of the tegmina..... 24. *E. affinis*.

¹This is conjectural but probable in *E. ornatissima* by the brief extent of the scapular area.²Conjectural again, but probable, with *E. ornatissima*.

Table of the European species of Etoblattina—Continued.

- d*². Tegmina more than 30 mm. long; course of the main scapular vein nearly or quite straight, at no point nearly attaining the middle line of the tegmina.
- e*¹. Tegmina subequal on distal half (apparently; the only specimen is broken), the externomedian vein with regular offshoots from the middle of the tegmina outward..... 25. *E. euglyptica*.
- e*². Tegmina tapering considerably throughout the distal half, the externomedian branches all arising close to the apex from two stems which unite at or before the middle of the tegmina.... 26. *E. elongata*.
- c*². Internomedian area nearly reaching the apex of the tegmina by the distal sinuosity of the main vein.
- d*¹. Externomedian vein first forking well before the middle of the tegmina, with many branches; distal portion of anal area with numerous branches..... 27. *E. stelzneri*.
- d*². Externomedian vein first forking at some distance beyond the middle of the tegmina, with few branches; distal portion of anal area with few branches 28. *E. weissigensis*.

ETOBLATTINA DEANENSIS sp. nov.

Pl. XII, figs. 1, 3.

The fore wing has a very regular elongate oval form, tapering with considerable regularity beyond the middle third of the tegmina, the anal area by its fullness interfering a little with the regularity; it is a little more than two and a quarter times as long as broad; the costal margin has a very regular and moderately convex curve, while the inner margin, beyond the fuller and more convex anal area, is nearly straight; the tip is imperfect in the two specimens known. The veins originate slightly above the middle of the tegmina and at first all curve upward, but not so strongly as in *E. primæva*, to which this species is most nearly allied, so that the externomedian vein passes more nearly through the middle of the tegmina. The mediastinal vein passes in a scarcely sinuous course to somewhat beyond the middle of the front margin, emitting about half a dozen nearly straight, simple or deeply forked branches. The scapular vein is broadly and gently sinuous, extending to the apical margin a very little above the apex, begins to fork before the middle of the proximal half of the tegmina, and has four subequidistant branches, of which the first is compound, the others forked or simple. The externomedian vein first forks near the middle of the tegmina, where it divides into two very similar, weakly arborescent, longitudinal stems carrying about ten or a dozen veinlets to the apical and to the outer portion of the inner margin. The internomedian vein is very regularly and rather gently arcuate except for a slight apical sinuosity which carries it nearly to the apical sixth of the tegmina, and has about five nearly straight branches, some of the basal ones simply or doubly forked. The anal furrow is not very deeply impressed, very regularly but not very strongly arcuate, and ends at about the middle of the

tegmina. The anal veins consist of two sets, rather widely separated at the base, the inner set consisting of a several-branched main stem subparallel to the anal furrow, the outer to four or five simply or doubly forked, approximated, slightly divergent nervules, more nearly longitudinal than the other set.

The two specimens known, one with its reverse, are coal black; the one with its reverse is nearly perfect, having lost only the shoulder and the apical margin; the other specimen consists of two tegmina, of one of which only the base and the anal area is preserved and which lies partially concealing the reversed face of the other, of which the basal portion and considerable of the apex is lost. Excepting in the anal and internomedian areas the veins are pronounced, being deeply incised; in the internomedian area they are very delicate. Toward the apex of the tegmina an exceedingly delicate reticulation can be detected in the interspaces, which gives way in the center of the tegmina to a very close series of dulled cross-lines, and become in the scapular area parallel to the nearer margin.

Length of the tegmina, 38 mm.; breadth, 13.25 mm.

The two specimens differ from each other in hardly anything but the simplicity or complexity of the several branches of the main veins, particularly in the upper stem of the externomedian vein and the principal branches of the internomedian vein. In one, however, the costal margin appears to be distinctly more arcuate than in the other.

The species is plainly most nearly allied to *E. primæva*, from which it differs in its more elongate form, apical tapering, the lack of an extreme basal branch of the scapular vein, the far greater importance though later branching of the externomedian vein, the narrower and shorter internomedian area and its simpler apical branching, the more regular curve of the anal furrow, the entire system of anal veins, and the lower course of all the main veins through the middle area of the tegmina.

The specimen with reverse, fig. 1, comes from Foxe's bridge, in the Forest of Dean, Gloucester, England. The other was collected by F. Stock at Crump meadow, in the Forest of Dean. Both are in the collection of Mr. R. D. Lacoe, in which they bear the number 2132 *a-b, c*.

VI. A LIST OF THE DESCRIBED EUROPEAN PALEOZOIC COCKROACHES.

The species in this list are arranged alphabetically under each genus, but the genera are in a natural order. Several species, because too imperfectly known, are not mentioned, as they can not be placed. Such are *Blattina ligniperda* Kušta, from Lubná, Bohemia; *B. neuropteroides* Göpp. and *B. rarinervis* Göpp., from an unnamed locality; *B. tischbeini* Gold., from Hirschbach, Germany, and *B. venosa* Gold., from Wemmetsweiler, Rhenish Prussia. *Etoblattina peachii* Woodw., from Kilmaurs, Scotland, is also omitted, as the undeveloped tegmina hardly allow it to be definitely placed.

A list of the described European Paleozoic cockroaches.

- Etoblattina* affinis (Gold.), Löbejün and Wettin, Saxony.
 anaglyptica (Germ.), Wettin, Saxony.
 bituminosa (Kušta)¹, Lubná, Bohemia.
 carbonaria (Germ.), Wettin, Saxony.
 deanensis Scudd., Forest of Dean, Gloucester, England.
 deichmülleri (Gein.)², Weissig, Saxony.
 didyma (Germ.), Wettin, Saxony; Manebach, Saxe-Weimar.
 dohrnii Scudd., Wettin, Saxony.
 dyadica (Gein.)³, Weissig, Saxony.
 elongata (Gein.), Weissig, Saxony.
 euglyptica (Germ.), Wettin, Saxony.
 flabellata (Germ.), Wettin and Weissig, Saxony.
 intermedia (Gold.), Wemmetsweiler, Rhenish Prussia.
 johnsoni Woodw., Dudley, England.
 labachensis (Gold.), Labach, Rhenish Prussia.
 lanceolata (Sterz.), Lugau, Saxony.
 leptophlebica (Gold.), Löbejün, Saxony.
 manebachensis (Gold.), Manebach, Saxe-Weimar.
 mantidioides (Gold.), Durham, England.
 ornatissima Deichm., Grügelborn, Rhenish Prussia.
 parvula (Gold.), Löbejün, Saxony.
 primæva (Gold.), Saarbrücken, Rhenish Prussia.
 propria Kliver, Saarbrücken, Rhenish Prussia.
 russoma (Gold.), Löbejün, Saxony.
 steinbachensis Kliv., Steinbachthal, Rhenish Prussia.
 stelzneri (Deichm.)⁴, Weissig, Saxony.
 weissigensis (Gein.), Weissig, Saxony.
- Gerablattina* clathrata (Heer), Manebach, Saxe-Weimar.
 geinitzi (Gold.), Löbejün, Saxony.
 germari (Gieb.), Wettin, Saxony.
 goldenbergi (Mahr), Manebach, Saxe-Weimar.
 mahri (Gold.), Manebach, Saxe-Weimar.
 münsteri Scudd., Wettin, Saxony.
 producta Scudd., Wettin, Saxony.
 robusta Kliv., Wemmetsweiler, Rhenish Prussia.
 rollei (Deichm.)⁵, Grügelborn, Rhenish Prussia.
 scaberata (Gold.), Altenwald, Rhenish Prussia.
 weissiana (Gold.), Brücken, Rhenish Bavaria.
- Anthracoblattina* camerata Kliv., Dudweiler, Rhenish Prussia.
 dresdensis (Gein.-Deichm.), Klein Opitz, Saxony.
 incerta Kliv., Dudweiler, Rhenish Prussia.
 lubnensis (Kušta)⁶, Lubná, Bohemia.
 porrecta (Gein.), Weissig, Saxony.
 remigii (Dohrn), Cusel, Rhenish Bavaria.
 rückerti (Gold.), Stockheim, Bavaria.
 scudderi Gold., Wemmetsweiler, Rhenish Prussia.
 sopita Scudd., Weissig, Saxony.
 spectabilis (Gold.), Weissig? and Löbejün, Saxony.
 wagneri Kliv., Löbejün, Saxony.
 winteriana (Gold.), Dudweiler, Rhenish Prussia.

¹ *Blattina* (*Etoblattina*) *bituminosa* Kušta.² *Blattina* (*Etoblattina*) *carbonaria*, var. *deichmülleri* Gein.³ *Blattina* (*Etoblattina*) *flabellata*, var. *dyadica* Gein.⁴ *Etoblattina flabellata*, var. *stelzneri* Deichm.⁵ *Etoblattina rollei* Deichm.⁶ *Blattina* (*Anthracoblattina*) *lubnensis*, Kušta.

A list of the described Paleozoic cockroaches—Continued.

- Hermatoblattina kirkbyi* (Woodw.), Fifeshire, Scotland.
lebachensis (Gold.), Lebach, Rhenish Prussia.
wemmetsweileriensis (Gold.), Wemmetsweiler, Rhenish Prussia.
- Progonoblattina fritschii* (Heer), Manebach, Saxe-Weimar.
helvetica (Heer), Erbignon, Switzerland.
- Oryctoblattina arndti* Kušta, Tíemošná, Bohemia.
oblonga Deichm., Weissig, Saxony.
reticulata (Germ.), Wettin, Saxony.
- Petrablattina gracilis* (Gold.), Lebach, Rhenish Prussia.
- Leptoblattina exilis* Woodw., Dudley, England.
insignis (Gold.), Dudweiler, Rhenish Prussia.

VII. THE TERMINOLOGY OF THE NEURATION.

In explanation of the terminology here used for the neuration of the tegmina and wings of Paleozoic cockroaches, and in which I have simply followed Heer, the accompanying figure of one of the tegmina of

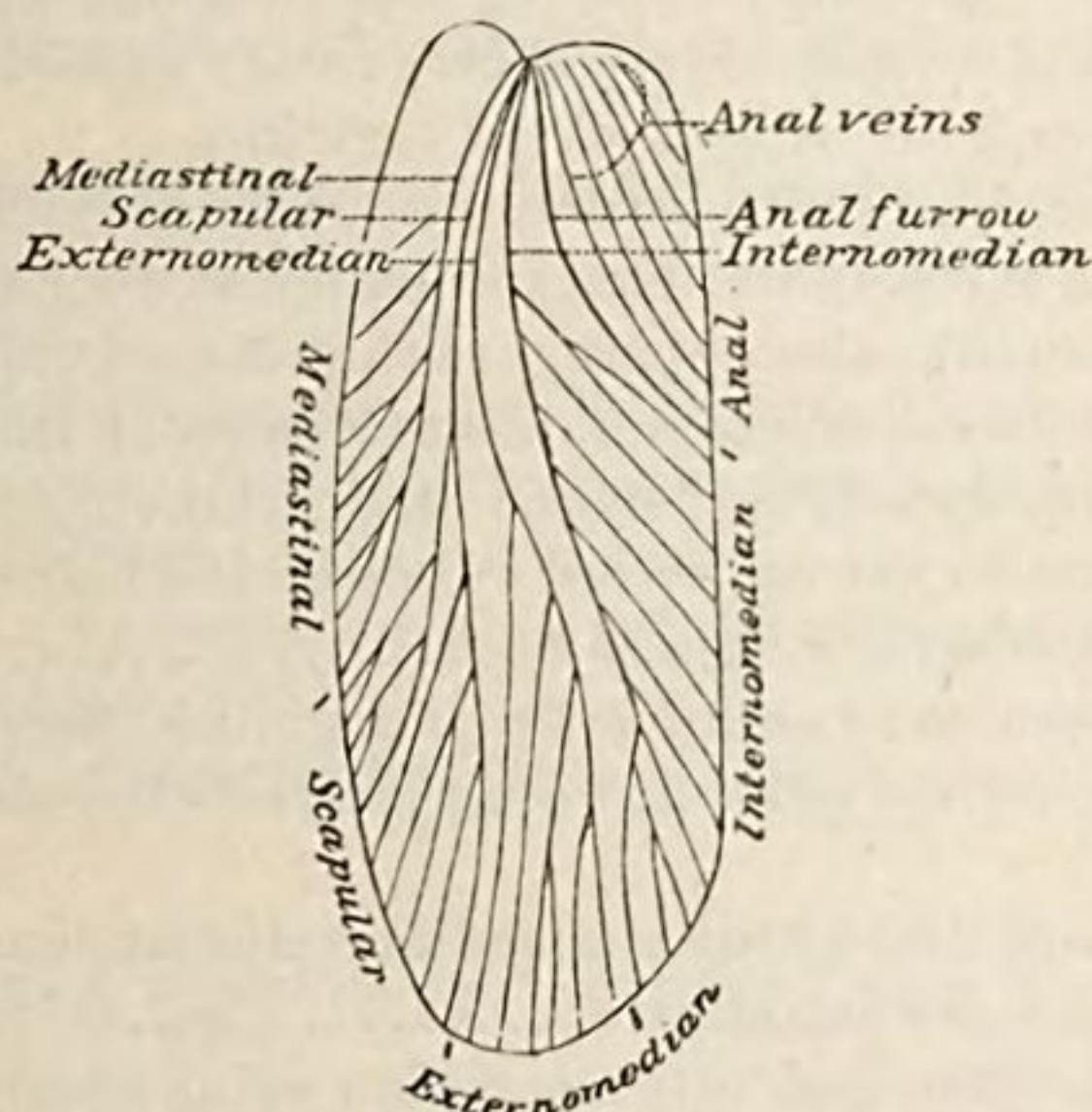


FIG 3.—*Etoblattina mazona*, with the nomenclature of the parts.

Etoblattina mazona from the Carboniferous beds of Illinois is introduced, enlarged two diameters, with the veins at the base of the tegmina named, and the areas marked along the margin. These names are employed in all the descriptions.

TABLE OF THE GENERA OF AMERICAN FOSSIL COCKROACHES.

This table is also applicable to the European genera, for one Paleozoic genus not yet found in America is included in it, distinguished by an asterisk following it. *Leptoblattina*, exclusively European, is not included, as the neuration of the tegmina is too obscure to place it.

A.¹ All six of the main veins of tegmina independent (excepting sometimes in the basal fourth of the tegmina); anal veins impinging on the hind margin PALÆOBLATTARIÆ.

B¹ Branches of the mediastinal vein arranged in a radiate manner, mostly springing from a common point at the base of the tegmina; mediastinal area subtriangular, uniformly tapering apically.... MYLACRIDÆ.

Table of the genera of American fossil cockroaches—Continued.

- c¹. All or very nearly all the branches of the mediastinal vein arising close to the base of the tegmina.
- d¹. Mediastinal and scapular areas together occupying less than half the tegmina.
- e¹. Scapular area larger than the mediastinal..... 1. *Mylacris*.
- e². Scapular area smaller than the mediastinal..... 2. *Promylacris*.
- d². Mediastinal and scapular areas together occupying half or more than half the tegmina.
- e¹. Tegmina narrow; externomedian area small and compressed, scarcely expanding apically..... 3. *Lithomylacris*.
- e². Tegmina broad; externomedian area expanding apically 4. *Paromylacris*.
- c². A number of the apical branches of the mediastinal vein arising beyond the base of the tegmina, and scarcely partaking of the radiate arrangement of the others 5. *Necymylacris*.
- B². Branches of the mediastinal vein arising at regular intervals from a principal stem; mediastinal area generally band-shaped.... BLATTINARIÆ.
- c¹. Internomedian vein long, terminating beyond, rarely at, the middle of the outer half of the tegmina; scapular and externomedian areas together generally covering less than one half of the tegmina.
- d¹. Mediastinal area comparatively short, rarely exceeding, seldom equaling, two-thirds the length of the tegmina.
- e¹. Externomedian branches inferior, so that the nervules divaricate on either side of the scapular-externomedian interspace.. 6. *Microblattina*.
- e². Externomedian branches superior, so that the nervules divaricate on either side of the externomedian-internomedian interspace.
- f¹. Scapular area extending beyond and embracing the extreme tip of the tegmina by the backward sweep of the main vein; externomedian area comparatively small 7. *Archimylacris*.
- f². Scapular area not reaching tip of tegmina, the extremity of the main vein curving only upward; externomedian area comparatively large.
- g¹. Externomedian and internomedian veins sinuous, distinctly diverging around a median stigma..... 8. *Spiloblattina*.
- g². Externomedian and internomedian veins nearly straight, with little or no median repulsion 9. *Etoblattina*.
- d². Mediastinal area long, usually at least three-fourths the length of the tegmina, sometimes nearly reaching the tip.
- e¹. Branches of scapular vein superior.
- f¹. Externomedian branches superior, so that the nervules divaricate on either side of the externomedian-internomedian interspace.
10. *Gerablattina*.
- f². Externomedian branches inferior, so that the nervules divaricate on either side of the scapular-externomedian interspace.
11. *Anthracoblattina*.
- e². Branches of scapular vein inferior 12. *Hermatoblattina*.*
- c². Internomedian vein short, terminating before the middle of the outer half of the tegmina; scapular and externomedian areas together generally covering more than half the tegmina.
- d¹. Branches of externomedian vein inferior.
- e¹. Principal veins closely crowded in the basal half of the tegmina; branches uniformly distributed all over the wing; scapular area terminating above the apex of the tegmina..... 13. *Progonoblattina*.

Table of the genera of American fossil cockroaches—Continued.

- e*². Principal veins widely separated in the basal half of the tegmina; branches much more closely crowded in some parts of the tegmina than in others; scapular area terminating below the apex of the tegmina..... 14. *Oryctoblattina*.
- d*². Some or all of the branches of externomedian vein superior.
- e*¹. Externomedian vein directed toward the distal half of inner border of tegmina; internomedian vein moderately long.. 15. *Poroblattina*.
- e*². Externomedian vein directed toward and terminating at or but little beyond the middle of the inner border of tegmina; internomedian vein very short..... 16. *Petrablattina*.
- A². Two or more of the six principal veins of tegmina amalgamated through the whole or the greater part of their length; most of the anal veins impinging on the anal furrow or forming a fusiform bunch directed toward the tip of the furrow..... NEOBLATTARIÆ.
- B¹. Surface of tegmina distinctly divided into four fields, each occupied by a principal vein (Mesozoic genera).
- c*¹. Tegmina diaphanous, rounded at tip, not strongly vaulted; anterior main vein sinuous, falling short of apex..... 17. *Neorthroblattina*.
- c*². Tegmina coriaceous, more or less pointed at tip, strongly vaulted at base; anterior main vein straight, terminating at or below the apex.
18. *Scutinoblattina*.
- B². Surface of tegmina not distinctly divided into four fields, but either into three or the neuration greatly confused by adventitious folds (Cenozoic genera).
- c*¹. Fore wings without a longitudinal fold; neuration normal.
- d*¹. Internomedian branches mostly arising from a dichotomous division of two main stems 19. *Zetobora*.
- d*². Internomedian branches mostly arising as simple inferior branches of two main stems 20. *Homoeogamia*.
- c*². Fore wings with a longitudinal fold, interfering with the neuration.
21. *Paralatindia*.

PALÆOBLATTARIÆ.

The geological range of this ancient type of cockroaches was formerly supposed to be limited to Paleozoic time and specifically to Carboniferous and Permian rocks; but it has since been shown that it occurs in some numbers in the Trias of Colorado, which now forms its upper limit; inferiorly it has been found scantily in the Millstone Grit, but there can be little doubt that its actual appearance on the earth was at a much earlier epoch.¹

Although our knowledge has been vastly extended within the past fifteen years and the number of known species has been multiplied nearly fourfold, principally from additions in this country, the number of genera has increased by only about two-thirds, and the number of primary groups remains the same. We are now acquainted with sixteen genera and about two hundred species, by far the larger part of which belong to one of the two principal divisions, the Blattinariæ.

¹*Palæoblattina douvillei* Brongn., from the lower part of the Upper Silurian of Jurques, Calvados, France, regarded by Brongniart as a cockroach, appears to me from his figures to belong to the neuropteroid series, and therefore it is not considered here.

MYLACRIDÆ.

This group of Palæoblattariæ, with a single exception (*Promylacris harei*), found in the Barren Coal-measures, is confined to the true Productive Coal-measures, and, as far as definitely known, to American deposits. Brongniart, as pointed out above (p. 21), states that Mylacridæ are common in the Coal-measures of Commeny, in France, and there is no reason to doubt his statement, but the proof of it has not yet been published. Considering that they are unknown in Permian or later rocks, and seem to represent an older type than the Blattinariæ,¹ it is a little surprising that they have not as yet, like several genera of Blattinariæ, been detected in the Millstone Grit. Their known geologic range is therefore considerably more confined than that of the Blattinariæ, which extend from the Millstone Grit to the Trias. Five genera and twenty-nine species have so far been detected, with indications of others. By far the majority occur in the older true Productive Coal-measures, and below the Barren Coal-measures they are nearly as abundant in species as the Blattinariæ, though representing fewer genera.

1. Genus MYLACRIS.

Mylacris Scudd., Worth., Geol. Surv. Ill., III, 568-569.

This genus is confined, so far as known, to North America, and is the richest of the Mylacridæ in species, fourteen in number, being thus in fact nearly as rich as all the other genera of Mylacridæ combined. It has been found in four different coal basins—the Acadian, the Rhode Island, the Pennsylvania, and the Eastern Interior, in the last two of which it is richest in species. As far as known, it is mostly confined to the Lowest Productive Coal-measures, though one of the two species of the anthracite fields of Pennsylvania (near the base of the division), *M. carbonum*, is common to them and the Lower Productive Coal-measures, and affords almost the only instance where one of our Carboniferous species has been found, even in two separate localities.

Table of the species of Mylacris.

*a*¹. Mediastinal area slender, especially at base.

*b*¹. Scapular nervules longitudinal, very long, and not numerous.. 1. *M. packardii*.

*b*². Scapular nervules oblique, numerous, and not very long.... 2. *M. bretonensis*.

*a*². Mediastinal area broad, especially at base.

*b*¹. Externomedian nervules superior or apical.

*c*¹. Externomedian nervules distinctly superior.

*d*¹. Costal margin considerably arcuate on the basal third of the tegmina, so that the humeral shoulder is well rounded.

*e*¹. Tegmina almost or quite two and a half times longer than broad.

3. *M. elongata*.

*e*². Tegmina hardly if any more than twice as long as broad.

*f*¹. Mediastinal area reaching only to the end of the middle third of the tegmina; internomedian vein with numerous closely crowded branches.

4. *M. anthracophila*.

¹ See my Paleozoic Cockroaches. Mem. Bost. Soc. Nat. Hist., III, 31, 32; Foss. Ins. N. A., I, 51-51.

Table of the species of Mylacris—Continued.

- f*². Mediastinal area reaching well into the distal third of the tegmina; internomedian vein with few and rather distant branches. 5. *M. gurleyi*.
- d*². Costal margin very slightly arcuate on the basal third of the tegmina, so that the humeral shoulder is very pronounced.
- e*¹. Scapular area much less important than the externomedian, the tegmina rapidly narrowing in the apical half..... 6. *M. ampla*.
- e*². Scapular area much more important than the externomedian, the tegmina much less rapidly narrowing apically.... 7. *M. priscovolans*.
- c*². Externomedian nervules rather apical than superior.
- d*¹. Externomedian area occupying the apex of the tegmina..... 8. *M. heeri*.
- d*². Externomedian area falling wholly below the middle line of the tegmina.
- e*¹. Mediastinal nervules comparatively few and distant; scapular vein forked at base..... 9. *M. antiqua*.
- e*². Mediastinal nervules numerous; scapular branches all emitted from a single main branch..... 10. *M. lucifuga*.
- b*¹. Externomedian nervules inferior.
- c*¹. Costal much more curved than inner margin.
- d*¹. Costal margin very strongly curved in the mediastinal area, which scarcely reaches to the middle of the tegmina..... 11. *M. carbonum*.
- d*². Costal margin gently curved in the mediastinal area, which extends considerably beyond the middle of the tegmina.. 12. *M. pennsylvanica*.
- c*². Costal and inner margins similarly and symmetrically curved.
- d*¹. Combined mediastinal and scapular areas as broad at the base as beyond. 13. *M. mansfieldii*.
- d*². Combined mediastinal and scapular areas much broader near the middle of the tegmina than at the base 14. *M. ovalis*.

1. MYLACRIS PACKARDII

Pl. I, figs. 2, 3.

Mylacris packardii Scudd., Bull. U. S. Geol. Surv. No. 101, pp. 11-12, pl. 1, figs. *e. g.* (1893).

From the Lowest (?) Productive Coal-measures at Bristol, R. I.

2. MYLACRIS BRETONENSIS.

Blattina bretonensis Scudd., Can. Nat., VII, 271-272, fig. 1 (1874).

Mylacris bretonensis Scudd., Mem. Bost. Soc. Nat. Hist., III, 41-42, 300, pl. 5, fig. 1 (1879); Foss. Ins. N. A., I, 61-62, 264, pl. 5, fig. 1 (1890).

From the Productive Coal-measures of Sydney, Cape Breton.

3. MYLACRIS ELONGATA sp. nov.

Pl. I, fig. 6.

The tegmina are unusually slender for a *Mylacris*, the specimen at hand, though incomplete at both extremities, being certainly two and a half times longer than broad; it is subequal in width on the basal half, but on the apical half narrows somewhat rapidly by the stronger arcuation of the costal margin, the inner margin being almost straight except at the extreme base and perhaps the tip; the extreme apex is

broken. The veins originate below the middle of the base and curve somewhat strongly upward before assuming their final direction, which for most of them is subparallel to the outer margin obliquely inward toward the tip. The mediastinal area is rather narrow for a *Mylacris*, and more than usually elongated, tapering more gradually than usual, and reaching almost or quite to the end of the middle third of the wing; most of the nervules are simple throughout. The main scapular vein begins to branch by or before the middle of the basal half of the wing, and while branching is almost exactly straight and subparallel to the outer margin, coursing through the middle of the wing, but just before emitting its last branch it is gently arcuate and assumes a course parallel to the inner margin; it sends off six branches parallel to the mediastinal branches, all simple except one, which is very deeply forked. The externomedian vein runs parallel to the scapular until it branches just before the middle of the wing, and then bends slightly downward and terminates on the inner margin, throwing off four principal nervules, the first of which is doubly forked. The internomedian vein is gently sinuate and parallel to the externomedian throughout its course, terminating on the inner margin shortly before the tip; its branches are mostly simple, but may be doubly forked, and are strongly oblique and arcuate, with their convexities toward the tip of the anal furrow. Anal area reaching nearly to the middle of the wing, strongly tumid; the anal furrow strongly arcuate but nearly straight in its apical third; the anal veins consist of two sets, one occupying almost the entire half of that portion lying next the anal furrow, consisting of a main vein with two branches, one of them forked, all with a gentle arcuation in the same sense as the anal furrow; the other consisting of a crowd¹ of parallel, strongly oblique, and simple or simply forked veins gently oblique in a sense opposite to that of the anal furrow, and occupying the inner basal half.

Length of fragment, 34 mm.; probable length of tegmina, 36 mm.; width, 15 mm.

This clearly marked species resembles most closely *M. anthracophila* from the same beds. The general relation of all the principal veins is almost precisely the same, but it is distinctly separated from that species by its form, which is much more slender than in *M. anthracophila* and thus gives to the mediastinal area in particular quite a different form.

A single specimen and its reverse were found in the Lowest Productive Coal-measures at Mazon Creek by Mr. J. C. Carr, and are now in the collection of Mr. R. D. Lacoe, of Pittston, Pa., and bear in his collection the number 2014 *a-b*.

¹Only a few of them have been represented by the artist; they occupy the entire inner basal portion of the area.

4. MYLACRIS ANTHRACOPHILA.

Pl. 1, figs. 1, 4.

Mylacris anthracophila Scudd., Worth., Geol. Surv. Ill., III, 568-570, figs. 5, 6 (1868); Mem. Bost. Soc. Nat. Hist., III, 45-47, pl. 5, figs. 6-8 (1879); Foss. Ins. N. A., I, 65-67, 271, pl. 5, figs. 6-8 (1890).

From the Lowest Productive Coal-measures at Colchester, Ill.

5. MYLACRIS GURLEYI sp. nov.

Pl. I, fig. 5.

The single specimen preserved in a nodule represents two tegmina and a portion of one of the under wings in a nearly natural position, but as if embracing a solid substance next the under surface, so as to present a strongly convex appearance, the cross section forming indeed almost exactly a semicircle, as seen in the line above indicating it. Neither of the tegmina is preserved entire, the tip of both, but no great portion, being lost, showing that the form of the tegmina was subtriangular, very broad at base but tapering rapidly and equably beyond to an apparently narrowly rounded apex, the form thus not differing in any essential respect from that of *M. anthracophila*. The whole wing is slightly more than twice as long as broad. The mediastinal area varies in the two wings, in the right terminating just at the end of the fragment at about the middle of the apical fourth of the wing, but in the left wing at the beginning of the apical fourth; the area is filled with a large number of simple or forked, usually apically forked, more or less arcuate, slightly diverging branches, subequidistant throughout the entire area. The scapular vein runs nearly parallel to the costal margin, but is much straighter than it, and terminates on the right at the extreme apex of the wing, on the left wing at a slight distance before it; on the right wing it does not branch until beyond the apical third, and in fact has but a single branch, which is deeply forked, the three veins running in an almost straight longitudinal course to the upper apex of the wing; in the left wing, however, it has four simple or rather deeply forked branches, the vein beginning to branch near the extreme base of the wing, and the branches thrown off at equal distances along the vein; on the right wing, therefore, the interspace between the scapular and the externomedian vein runs almost exactly through the middle of the wing; it does so also on the left wing through the basal half of the same, but thereafter curves very slightly upward so as to terminate, as before remarked, above the tip. The externomedian vein is similarly different in the two wings; on the right wing it has an arcuate course and terminates on the inner margin at a considerable distance short of the end of the mediastinal area, and emits but three straight, longitudinal branches, the first beyond the middle of the wing; on the left wing it is much straighter and terminates on

the inner margin a long distance beyond the apex of the mediastinal area, and has but two branches, the first of which, arising but shortly beyond the basal third of the wing, is compound, while the second arises at the beginning of the apical third of the wing, the area occupying the apex of the wing, more, however, upon its inner than its costal side. The internomedian vein runs exactly parallel to the externomedian and is therefore more curved on the right than on the left wing, and has three or four simple or deeply-forked branches which arise at equal distances on the left wing but at very unequal distances on the right. The anal furrow is deeply impressed, but its apical portion is lost in both wings; it appears, however, to terminate beyond the basal third of the wing and to be strongly arcuate at the base, beyond nearly straight; the anal area is filled with a number of mostly simple branches, but on the right wing many of them originate at equal distances apart from the vein which runs subparallel and next to the anal furrow, while on the left wing it is one of the middle veins which is compound.

A broken portion of one of the hind wings is preserved, that of the right side, which seems to show that the externomedian and internomedian veins were somewhat similar to those of the fore wing, but that they had a straight, longitudinal course instead of being strongly arcuate, as in the fore wing, and the internomedian branches arise at equal distances apart.

This insect appears at first sight to show a greater difference between the neuration of the two fore wings than any other species which has yet been described, but in reality the difference is almost entirely made up by the greater extent of the mediastinal area on the right wing and the consequent pushing of all the succeeding areas farther along to the final reduction of the internomedian area. It, and especially the left wing, resembles very closely *M. anthracophila* from the same region, but differs from it markedly in the much slighter importance of the externomedian vein, although the space occupied upon the margin by this area is scarcely less. Nevertheless, on account of the difference in venation of the two wings, I had a brief hesitation to recognize it as distinct from *M. anthracophila*, but until further remains are obtained it seems wiser so to regard it. Indeed, the range of variation in the species of ancient cockroaches is a question which, even with our present greatly extended knowledge of them, it is difficult to decide, and we must still await a larger amount of material before we can come to any safe conclusion.

Length of longest fragment of tegmina, 25 mm.; probable length of tegmina, 27 mm.; breadth, 13 mm.

A single specimen from the Lowest Productive Coal-measures at Mazon Creek, Illinois, showing obverse and reverse, was obtained by Mr. W. F. E. Gurley.

6. MYLACRIS AMPLA sp. nov.

Pl. II, fig. 1.

Two well-preserved tegmina lying nearly in place, but a little separated from each other by crushing, represent this species, besides which a few segments of the abdomen are perceptible. The tegmina are unusually broad and are pretty well preserved, only the apical portion of one and the apical outer marginal portion of the other being lost at the edge of the stone. The humeral shoulder is particularly well marked, almost exactly rectangulate, with the extreme angle rounded, while the outer margin, at least in its basal half, is gently emarginate and slightly recurved. The wing is somewhat less than twice as long as broad, with the inner margin apparently nearly straight, perhaps very gently convex; the outer margin gently convex in the basal half, rather strongly convex on the apical half, so that the wing narrows rapidly behind; the form of the tip, however, can not be determined. The main veins originate at about the middle of the base of the wing, and are gently arcuate or sinuate throughout most of their course. The relative importance of the different areas appears to vary distinctly in the two wings, and the mediastinal area is of grand importance, partly on account of its great lateral expanse at the base, partly from its long extension along the outer margin, for, on the complete right wing, where it appears to be more highly developed, it extends to beyond the middle of the apical half of the outer margin and is filled with radiating veins, many of them forked and apparently formed mainly of two clusters, an outer and basal, in which the forks originate near the middle of their course, and an inner, where they are variable. The mediastinal vein takes a sinuate course, and with the externomedian appears to be more variable than any of the others; together they occupy the apex of the wing, and apparently, to judge from one wing, may unite near the middle of the basal half of the wing and form one basal stem, or they may be entirely independent, one of the other, as in the opposite wing. In the former case, as is seen in the right wing in the drawing on the plate, the scapular vein is of small importance, having but three branches, one of them once forked near the tip and terminating somewhat before the tip of the wing, while the externomedian vein occupies the entire tip of the wing, terminating on the inner border opposite the extremity of the mediastinal area and filling the space with three or four compound or forked branches. On the left wing, however, the scapular vein is of decidedly greater importance, having at least four branches, the first of them compound, and it must terminate much nearer the apex of the wing (here broken) than can be the case upon the opposite side; while the externomedian, entirely independent from its very origin, divides into two branches at no great distance before the middle of the wing, each of which branches, and especially the lower, is compound; having a general effect similar to that of the same vein on the opposite

wing, but with more crowded neurulation. The internomedian vein is obscure upon the right wing but clearly marked upon the left; its termination, however, is plainly similar in both; on the left wing it is seen to have four principal branches, of which the second, at least, is forked, while the other appears to be simple; its course is gently sinuate, having beyond its arcuation in the basal half a distinctly more longitudinal trend. The anal furrow is rather strongly and pretty uniformly arcuate and terminates very shortly before the middle of the wing; the anal area, which is rather strongly vaulted, is filled with a series of eight or ten veins, gently arcuate in the same sense as the furrow and either simple or united to one another close to their base. Little more can be said of the abdominal segments than that they are rather short and broad and appear to be perfectly smooth, showing no structure whatever.

Length of the longest fragment of the tegmina, 30 mm.; probable length of tegmina, 33 mm.; breadth, 17 to 18 mm.; breadth of the two tegmina as they lie upon the stone, 35 mm.; length of abdominal segments, 2 mm.

This species is more nearly related to *M. priscovolans* than to any other, but is remarkable for its extreme breadth, being much broader in proportion to its length than even in that species, but showing a somewhat similar length of the mediastinal area and distribution of the branches of the nervules therein. It differs in the much earlier origin of the branching of the externomedian vein and in general resembles *M. priscovolans* more by its left wing than by its right. The branch of the anal area is very different, as also the form of the wing.

The single specimen and its reverse, remarkably well preserved as to texture and of a fusco-castaneous color, are embedded in a nodule from the Lowest Productive Coal-measures, at Mazon Creek, Illinois, in the collection of Mr. R. D. Lacoe, where they bear the number 2021 *a-b*.

7. MYLACRIS PRISCOVOLANS.

Mylacris priscovolans Scudd., Mem. Bost. Soc. Nat. Hist., III, 307-308, pl. 27, fig. 9 (1884); Foss. Ins. N. A., I, 271-272, pl. 13, fig. 9 (1890).

From the bituminous coal shale of the Lowest Productive Coal-measures of Cannelton, Pa.

8. MYLACRIS HEERI.

Blattina heeri Scudd., Can. Nat., VII, 272, fig. 2 (1874).

Mylacris heeri Scudd., Mem. Bost. Soc. Nat. Hist., III, 43-44, pl. 5, fig. 11 (1879); Foss. Ins. N. A., I, 63-64, 264, pl. 5, fig. 11 (1890).

Productive Coal-measures of Sydney, Cape Breton.

9. MYLACRIS ANTIQUA.

Pl. II, figs. 5, 6.

Mylacris antiqua Scudd., Mem. Bost. Soc. Nat. Hist., III, 300-301 (1884); Foss. Ins. N. A., I, 264-265 (1890).

From the Lowest Productive Coal-measures at Mazon Creek, Illinois.

10. MYLACRIS LUCIFUGA.

Mylacris lucifuga Scudd., Mem. Bost. Soc. Nat. Hist., III, 301-302, pl. 27, fig. 8 (1884); Foss. Ins. N. A., I, 265-266, pl. 13, fig. 8 (1890).

From the roof shales of the E seam of coal at the Port Griffith switchback, near Pittston, Pa.

11. MYLACRIS CARBONUM.

Mylacris carbonum Scudd., Mem. Bost. Soc. Nat. Hist., III, 304-307, pl. 27, figs. 6, 7, 10 (1884); Foss. Ins. N. A., I, 268-271, pl. 13, figs. 6, 7, 10 (1890).

This is the only species of Paleozoic cockroach (with the possible exception of *Etoblattina balteata*) yet found in America at two distinct horizons, one of them being in the bituminous coal shale of the Lowest Productive Coal-measures of Pennsylvania, at Cannelton, the other in the higher series at the horizon of the E vein in the Empire mine at Wilkesbarre, in the same State. Some differences appear in the specimens from the two localities, and it is possible that when complete specimens are found it may be necessary to separate the older and younger forms.

12. MYLACRIS PENNSYLVANICA.

Mylacris pennsylvanica Scudd., Mem. Bost. Soc. Nat. Hist., III, 44-45, pl. 5, figs. 13, 14 (1879); *ibid.*, III, 302-304, pl. 27, fig. 11 (1884); Foss. Ins. N. A., I, 64-65, 266-268, pl. 5, figs. 13, 14, pl. 13, fig. 11 (1890).

From the bituminous coal shales of the Lowest Productive Coal-measures at Cannelton, Pa.

13. MYLACRIS MANSFIELDI.

Mylacris mansfieldi Scudd., Mem. Bost. Soc. Nat. Hist., III, 47, pl. 5, fig. 15 (1879); *ibid.*, IV, 377-378 (1890); Foss. Ins. N. A., I, 67, 272, 401-402, pl. 5, fig. 15 (1890).

From the same as the preceding.

14. MYLACRIS OVALIS.

Mylacris ovalis Scudd., Mem. Bost. Soc. Nat. Hist., III, 308-309, pl. 27, fig. 5 (1884); Foss. Ins. N. A., I, 272-273, pl. 13, fig. 5 (1890).

From the same as the last two.

2. Genus PROMYLACRIS.

Promylacris Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 34 (1885).

This genus, of which four species are known, has apparently a wider range than any of the other genera of Mylacridæ, having been found not only in the Lowest Productive Coal-measures in the Eastern Interior basin, where three species occur, but also, in a single instance, in the Barren Coal-measures of the Western Interior basin.

Table of the species of Promylacris.

- a*¹. Prothorax distinctly twice as broad as long. Scapular vein much more important than the externomedian.
- b*¹. Most of the scapular branches arising at regular intervals from the main stem. 1. *P. harei*.
- b*². About half the scapular branches clustered as offshoots of its basal branch. 2. *P. testudo*.
- a*². Prothorax distinctly less than twice as broad as long. Scapular vein not more important than the externomedian.
- b*¹. Prothorax more than half as broad again as long. Scapular vein far less important than the externomedian; anal veins simple..... 3. *P. ovalis*.
- b*². Prothorax less than half as broad again as long. Scapular vein not far less important than the externomedian; anal veins mostly forked..... 4. *P. rigida*.

1. PROMYLACRIS HAREI sp. nov.

Pl. II, fig. 3.

A single fore wing from which the anal area is lost and in which the details of the internomedian area are also lost; it is of a regular oval form, except for the straightness of the inner margin, the costal margin being strongly arcuate throughout and the tip broadly rounded; the whole wing is slightly more than twice as long as broad. The mediastinal area terminates at the middle of the costal margin and is filled at least in its outer two-thirds with radiating, straight, forked, rather closely crowded branches, of which some eight or ten reach the margin at equal distances apart. The scapular vein is strongly sinuous and in the basal half of the wing subparallel to the costal margin, terminating just above the extreme apex of the wing; it has half a dozen subequidistant branches, most of them deeply, sometimes doubly forked, the first arising far toward the base and not diverging from the main stem for some distance and then separating into three branches, the outermost apically forked; these branches are nearly straight, less crowded than those of the mediastinal area, oblique, the apical ones longitudinal. The externomedian vein runs parallel to the scapular and does not branch until beyond the middle of the wing, when it throws off three longitudinal branches to the outer margin, the uppermost deeply forked. The course of the internomedian vein and its branches can not certainly be determined, but it terminates shortly before the apex of the wing and has on the margin numerous oblique branches, apparently similar in all respects to those of the scapular area. The anal furrow is slightly impressed, in its apical portion nearly straight, and terminates exactly at the middle of the wing.

In the form of the wing, which is less tapering than usual, this species seems to be most nearly allied to *P. testudo*, but differs considerably from it in the character of its scapular branches.

Length, 17.5 mm.; breadth, 8.5 mm.

This interesting specimen, the only species of Mylacridæ known from above the Productive Coal-measures, was found by Mr. Sidney J. Hare,

a most enthusiastic searcher and student in natural history, about 170 feet above the base of the Upper Barren Coal-measures at Kansas City, Mo., and is named after him at the suggestion of Mr. R. D. Lacoe, in whose collection it bears the number 2087a.

2. PROMYLACRIS TESTUDO.

Pl. II, fig. 2.

Promylacris testudo Scudd., Mem. Bost. Soc. Nat. Hist., IV, 403, pl. 32, fig. 6 (1890);
Foss. Ins. N. A., I, 379, pl. 24, fig. 6 (1890).

Through the kindness of Mr. R. D. Lacoe, I have had the opportunity of examining a second specimen of this species. It is somewhat smaller than the first, but has the same vaulted form, and in each case the figure represents the convex surface and not the concave cast. The first thing that will be noticed is that there is a similar difference in the venation of the opposite tegmina, only that the difference is reversed, the simpler form of branching of the scapular vein being seen on the left side in one specimen, on the right side in the other. The drawing of the mediastinal vein of the left wing in the present specimen is slightly incorrect in that the forking of the branches has been overlooked, it differing but little from that of the opposite wing. The costal margin is scarcely so convex as in the type; the mediastinal area is a little longer, terminating a little beyond the tip of the anal furrow. On each wing the branches of the scapular vein are divided into two sets just beyond the middle of the basal half of the wing, but on the left side, from the less numerous branches, the vein is less complicated than on the right, where the outer of the two at once forks into two sets of three or four branches each, and the inner divides farther out in very regular fashion into two ultimately forked branches, giving in all eleven veinlets to the margin; on the left side the outer divides into three superior branches, the inner, at first into two, the outer of which is simple, the inner of which sends from before its middle a forked superior branch, in all only seven veinlets at the margin. In the type, on the more complicated left side, by the apical forking of nearly all the branches, no less than eighteen veinlets are found upon the margin; the right side, being broken at the margin, the number of apical veinlets can not be determined, but it is probably from ten to thirteen. The externomedian vein differs from the type mainly in its later initial forking, which is decidedly beyond that of the scapular vein and but little before the tip of the anal furrow. The internomedian area is larger on the left than on the right wing, but does not differ essentially from the same area in the type. The anal furrow is entirely similar to that of the type (which is wrongly stated in the original description to terminate "a little beyond," instead of a little before, the middle of the wing), and as there the anal area is strongly vaulted, but its veins are less numerous, and one at least is deeply forked.

Length of the fragment, 13 mm.; probable length of tegmina, 15 mm.; breadth of closed tegmina, 12.5 mm.

The specimen is numbered in Mr. Lacoe's collection 2089*a*, and, like the original, comes from the Lowest Productive Coal-measures at Mazon Creek, Illinois.

3. PROMYLACRIS OVALIS.

Promylacris ovalis Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 34-35 (1885); Mem. Bost. Soc. Nat. Hist., IV, 403, 404, pl. 31, figs. 1-4 (1890); Foss. Ins. N. A., I, 379, 380, pl. 23, figs. 1-4 (1890).

From the Lowest Productive Coal-measures at Mazon Creek, Illinois.

4. PROMYLACRIS RIGIDA.

Pl. III, fig. 1.

Promylacris rigida Scudd., Mem. Bost. Soc. Nat. Hist., IV, 403, 404-405, pl. 31, fig. 6 (1890); Foss. Ins. N. A., I, 379, 380-381, pl. 23, fig. 6 (1890).

From the Lowest Productive Coal-measures at Braidwood, Ill.

3. Genus LITHOMYLACRIS.

Lithomylacris Scudd., Mem. Bost. Soc. Nat. Hist., III, 48 (1879); Foss. Ins. N. A., I, 68, (1890).

This is the only genus of Mylacridæ which has been found more abundantly in the Younger than in the Older Productive Coal-measures, three out of the four species being confined to them in the Pennsylvania rocks, while the remaining species is found low down in the Older Productive Coal-measures in the Eastern Interior basin at Mazon Creek, Illinois.

Table of the species of Lithomylacris.

*a*¹. Externomedian vein first forking at or before the middle of the tegmina.

*b*¹. Tegmina slender, fully three times as long as broad.

*c*¹. Nervules numerous and very crowded; scapular branches often forked.

1. *L. angusta*.

*c*². Nervules less numerous and neuration more open; scapular branches always simple..... 2. *L. pittstoniana*.

*b*². Tegmina relatively stout, being but little more than twice as broad as long.

3. *L. pauperata*.

*a*². Externomedian vein first forking well beyond the middle of the tegmina.

4. *L. simplex*.

1. LITHOMYLACRIS ANGUSTA.

Lithomylacris angusta Scudd., Mem. Bost. Soc. Nat. Hist., III, 48-50, pl. 5, figs. 2, 3 (1879); Foss. Ins. N. A., I, 68-70, pl. 5, figs. 2, 3 (1890).

From the roof shales of the E seam of coal at the Port Griffith switch-back, near Pittston, Pa.

2. LITHOMYLACRIS PITTSTONIANA.

Lithomylacris pittstoniana Scudd., Mem. Bost. Soc. Nat. Hist., III, 50-51, pl. 5, figs. 4, 10 (1879); Foss. Ins. N. A., I, 70-71, pl. 5, figs. 4, 10 (1890).

From the same locality and horizon as the preceding.

3. LITHOMYLACRIS PAUPERATA.

Lithomylacris pauperata Scudd., Mem. Bost. Soc. Nat. Hist., IV, 409-410, pl. 32, fig. 5 (1890); Foss. Ins. N. A., I, 385-386, pl. 24, fig. 5 (1890).

From the same locality and horizon as the last two.

4. LITHOMYLACRIS SIMPLEX.

Lithomylacris simplex Scudd., Mem. Bost. Soc. Nat. Hist., III, 51-52, pl. 5, fig. 5 (1879); Foss. Ins. N. A., I, 71-72, pl. 5, fig. 5 (1890).

From the Lowest Productive Coal-measures at Danville, Ill.

4. Genus PAROMYLACRIS.

Paromylacris Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 35 (1885).

This genus, containing five known species, is confined to the Productive Coal-measures and almost entirely to its lowest members, only one species occurring near Pittston, Pa., near the base of the upper of the two divisions into which I have tentatively divided the Productive Coal-measures. One of the others occurs in the Western Interior coal basin, within 50 feet of the base of the true Coal-measures, the others in the Eastern Interior basin in the Mazon Creek beds, Illinois.

Table of the species of Paromylacris.

- a*¹. Tegmina broadly and pretty regularly obovate, the apical not much less than the basal breadth.
- b*¹. Prothorax much more than twice as broad as long; anal furrow terminating at or before the middle of the tegmina..... 1. *P. rotunda*.
- b*². Prothorax much less than twice as broad as long; anal furrow terminating well beyond the middle of the tegmina..... 2. *P. ampla*.
- a*². Tegmina tapering strongly, the apical much less than the basal breadth.
- b*¹. Mediastinal area reaching well beyond the middle of the tegmina; externomedian veins very strongly arcuate 3. *P. triangularis*.
- b*². Mediastinal area not reaching the middle of the tegmina; externomedian veins very gently arcuate..... 4. *P. clintoniana*.

P. pluteus is not included in this table.

1. PAROMYLACRIS ROTUNDA.

Paromylacris rotunda Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 35 (1885); Mem. Bost. Soc. Nat. Hist., IV, 406-408, pl. 32, figs. 1, 2 (1890); Foss. Ins. N. A., I, 382-384, pl. 24, figs. 1, 2 (1890).

From the Lowest Productive Coal-measures at Mazon Creek, Illinois.

2. PAROMYLACRIS AMPLA.

Pl. III, fig. 4.

Paromylacris ampla Scudd., Mem. Bost. Soc. Nat. Hist., IV, 408, pl. 31, fig. 7 (1890); Foss. Ins. N. A., I, 384, pl. 23, fig. 7 (1890).

From the Lowest Productive Coal-measures at Braidwood, Ill.

3. *PAROMYLACRIS TRIANGULARIS* sp. nov.

Pl. III, fig. 3.

Represented by a somewhat confused mass of wings, out of which one of the tegmina can be easily distinguished throughout the most of its extent, the tip only broken; this has a remarkably triangular form, the front margin strongly arcuate at the base but beyond straight, the inner margin independently arcuate on the anal area and beyond, the whole wing tapering rapidly and regularly beyond the tip of the anal furrow. The whole wing is a little more than twice as long as its extreme breadth next the base. The mediastinal area is of great extent, terminating about the middle of the distal half of the wing, very broad at the base and gradually tapering, the branches of the vein mostly forked, sometimes doubly forked, and several of them originating beyond the base of the wing, as is the case with other species of *Paromylacris*, in which respect this genus approaches *Necomylacris*; the branches are strongly oblique and not very closely crowded; the mediastinal vein is very strongly sinuous, first forks immediately after its separation from the internomedian vein, with which it is united in the basal fifth of the wing, each of its forks again almost immediately subdivided, and their lowermost branches, very deeply forked, send at last about half a dozen nervules to the upper margin, the lowermost striking the tip of the wing; all these branches are but gently sinuous in the apical half of the wing and directed longitudinally upward; the externomedian vein is very similar to the scapular, forking immediately on its freedom from the scapular, each of its branches again forking in the middle of the wing, all having a strongly sinuous course, and after their final forking nearly longitudinal. The internomedian vein is likewise broadly sinuous, and terminates on the inner margin somewhat beyond a point opposite the tip of the mediastinal vein, the main branch having a sinuous course parallel to the lower branches of the externomedian vein; it has three or four simple or forked branches, separating fan-like upon the anal border. The anal furrow is very deeply impressed, very strongly sinuous, and terminates on the inner margin considerably before the middle of the wing; the only veins which can be seen in the anal area are those on the half which is removed from the anal furrow, and they are here straight and parallel.

Length of fragment, 17 mm.; probable length of tegmina, 21.5 mm.; breadth, 10 mm.

A single specimen and its reverse come from the nodules of Mazon Creek, Illinois, and are in the collection of Mr. R. D. Lacoe, bearing the number 2110 *a*, *b*. They come from the Lowest Productive Coal-measures.

4. PAROMYLACRIS CLINTONIANA sp. nov.

Pl. III, fig. 6.

A single well-preserved fore wing with the extreme base and apex destroyed. The form of the tegmina is not so distinctly triangular as in the preceding species, but it tapers with great regularity from the same point, mostly through the arcuation of the inner margin, the front margin being very gently arcuate, so that the tip must fall above the middle, which is very unusual. The mediastinal area is rather short, scarcely extending so far as the anal furrow; very broad at base, it rapidly narrows, and is filled with but few branches, most of which are forked close to the margin, and, as in the species of *Paromylacris* in general, one at least of the principal branches originates far beyond the base of the tegmina. The scapular vein is the most important in the tegmina, occupying with its branches a very considerable portion of its area. It is made up of two clusters which part at no great distance from the base of the tegmina, the uppermost bearing three long branches, part of which are forked next the margin, following the general course of the branches of the mediastinal area. The lower cluster subdivides into two sets at about the end of the basal third of the tegmina—the upper composed of three, the lower of four, long, gently arcuate, upturned, simple branches, which cover the remainder of the front margin as far as the tip of the tegmina; as a whole, the main scapular vein, or rather the main vein of the lower cluster, has a gently sinuous course through the middle of the tegmina, falling below it in its middle portion. The externomedian vein is formed of two slightly compound branches originating from a main stem, which first subdivides a little beyond the first forking of the lower cluster of the scapular vein. Its branches are very gently sinuous, nearly longitudinal, and terminate on the outer and inner borders of the tegmina. The internomedian vein is very gently sinuous, running in a nearly straight course after its basal arcuation to the middle of the apical half of the tegmina, and has five simple, in one case rather deeply forked, straight and oblique branches. The anal furrow is deeply impressed, sharp, and gently arcuate, and, what is most extraordinary, forks just before the tip, and terminates at about the middle of the tegmina. The anal veins are longitudinally oblique, deeply forked, straight or arcuate, rather distant, and subparallel to the basal half of the anal furrow.

This species is remarkable for the slenderness of the tegmina and the curious manner in which they taper by the stronger arcuation of the inner than of the front margin; it is more nearly allied to the preceding species than to any other, but departs widely from it in these respects.

Length of fragment, 15 mm.; probable length of tegmina, 21 mm.; breadth, 8 mm.

Obtained from a coal bank near Clinton, Mo., belonging to the Very Lowest Productive Coal-measures, found within 50 feet of their extreme base; it is in the collection of Mr. R. D. Lacoë, under the number 2151 *a*.

5. PAROMYLACRIS? PLUTEUS sp. nov.

Pl. III, fig. 2.

A basal fragment of a fore wing appears to belong to a distinct species of *Paromylacris*, but is referred here doubtfully, as its reference depends largely upon the form of the wing, the larger part of the margin of which is conjectural. That it is one of the *Mylacridæ* is evident from the character of the preserved part of the mediastinal area. The direction of the inner margin beyond the anal area, with the direction and tendencies of the mediastinal and scapular veins, indicate that these two veins occupy at least one-half of the tegmina; while, if this were the case, the wing could hardly have had the slender form of *Lithomylacris*, as apparently also it had not the apically confined area of the externomedian vein. These points would indicate that it fell in *Paromylacris*, though it is not impossible that it is a *Necymylacris*, its next neighbor. In either case the structure of the anal area is different from anything known in this vicinity, and indicates a species hitherto unknown and of considerable size.

Assuming the margin to be correctly delineated, the mediastinal area probably extended to some distance beyond the middle of the tegmina, and the scapular area occupied the rest of the upper half of the tegmina, the main vein of the latter beginning to branch just beyond the basal fifth of the tegmina, where it is bent in its course. The externomedian vein runs parallel to the scapular, first branches before the middle of the tegmina, and apparently occupies on the margin almost half as much space as the scapular. The internomedian vein, of which more can be seen, runs in a very gently arcuate course and terminates far toward the tip of the tegmina, with three or four very inequidistant, deeply forked or simple, nearly straight or slightly arcuate, strongly oblique branches. The anal furrow terminates beyond the middle of the tegmina, and besides being strongly bent next the base is again gently bent beyond the middle of the remainder, being otherwise nearly straight; and by the fullness of this portion of the inner margin which has an independent curve, the whole area is subequal in breadth to near its rapidly tapering extremity; it is filled, at least away from the anal furrow, with numerous simple or deeply forked veins parallel to its sides, but arcuate apically. The whole area is fully three times as long as broad.

The species appears to fall in the near vicinity of *P. ampla*, but is smaller than it, and apparently has a larger development of the internomedian area and an earlier branching of the externomedian vein.

Length of fragment, 21.5 mm.; probable length of tegmina, 30 mm.; probable breadth, 16 mm.

A single specimen found in the Butter mine at Pittston, Pa., in the shale over the E coal or Pittston coal by Mr. R. D. Lacoe, in whose collection it bears the number 2040a.

5. Genus NECYMYLACRIS.

Necmylacrís Scudd., Mem. Bost. Soc. Nat. Hist., III, 52-53 (1879); Foss. Ins. N. A., I, 72-73 (1890).

The two known species of this genus both occur in the Pennsylvania coal basin, in the Lowest Productive Coal-measures. No species have been added to the genus since its first description fourteen years ago.

Table of the species of Necmylacrís.

Mediastinal vein short; internomedian vein arcuate throughout..... 1. *N. lacoana*.
Mediastinal vein long; internomedian vein straight through most of its course but little arcuate..... 2. *N. heros*.

1. NECYMYLACRIS LACOANA.

Necmylacrís lacoana Scudd., Mem. Bost. Soc. Nat. Hist., III, 53-54, pl. 5, fig. 12 (1879); Foss. Ins. N. A., I, 73-74, pl. 5, fig. 12 (1890).

From the Boston mine, near Pittston, Pa., in the Lowest Productive Coal-measures.

2. NECYMYLACRIS HEROS.

Necmylacrís heros Scudd., Mem. Bost. Soc. Nat. Hist., III, 54-56, pl. 5, fig. 9 (1879); Foss. Ins. N. A., I, 74-76, pl. 5, fig. 9 (1890).

From the roof shales of coal C in the Boston mine near Pittston, Pa., in the Lower Productive Coal-measures. By error in the original description it was referred to Cannelton, Pa., in a deposit just below vein C, and its discovery was credited to Mr. Mansfield, when it should have been referred to Mr. Lacoe, in whose collection it bears the number 2006. This error of location was unfortunately repeated in my Fossil Insects of North America, and in my Index to Known Fossil Insects (Bull. 71, U. S. Geol. Survey).

DESCRIPTION OF A FRAGMENT OF A GIGANTIC FORE WING.

MYLACRIDÆ (?) sp.

Pl. II, fig. 4.

The merest fragment of a fore wing, consisting only of the humeral lobe, is shown here to draw attention to an unknown species remarkable for its immense size and for the surface structure. It seems to be pretty certainly a cockroach, and appears to have rather the aspect of one of this group than that of one of the Blattinariæ. The shoulder of the wing is apparently penetrated by a single straight vein without

branches, unless the doubly forked bent prominence may be an extreme basal branch. The entire surface is covered with little, circular, shallow punctures, about 0.28 mm. in diameter, slightly more deeply impressed at their margins than centrally, sparsely distributed with considerable uniformity, but rather more closely crowded toward the margin, where they lie at an average distance apart of four or five of their diameters. The fragment is 25 mm. long, but, being only the merest fragment of the shoulder of a fore wing, must represent one very much larger than the largest known species, or perhaps one 80 mm. long, at the least.

The specimen comes from the Lowest Productive Coal-measures of Mazon Creek, Illinois, and was sent me for examination by Mr. William Gurley.

BLATTINARIÆ.

This group of Palæoblattariæ was the prevailing type of cockroaches in Carboniferous times. In America they are found from the Millstone Grit (in scanty numbers, but some variety—two or three genera) to the Trias, where the species, mostly belonging to generic groups characteristic of the Trias, are only two or three times more abundant than in the Millstone Grit, though the culmination of the group is reached in the Permian. In Europe they have been discovered neither so low as the Millstone Grit nor so high as the Trias, but are found throughout the true Productive Coal-measures, as well as in the Barren Coal-measures (where they appear to have culminated) and in the Permian. This latter statement may require some revision when the numerous species found in the Productive Coal-measures at Commentry, France, are made known, just as a very different statement regarding the American rocks would have had to be made fifteen years ago.

Twelve genera and about 174 species are known, of which 10 genera and about 112 species come from America, and 8 genera and about 62 species from Europe, besides half a dozen undetermined species from the latter. Six of the genera are common to both worlds, 4 are peculiar to America (one of them to the Trias), and 2 to Europe. No species are known to occur on both continents.

6. Genus MICROBLATTINA (*μικρός*, Blattina, nom. gen.) gen. nov.

The apical half of a fore wing from the Rhode Island coal field presents such very striking peculiarities that they must be regarded as affording sufficient ground for distinct generic reference unless the unknown basal portion should show the veins to be connected in a very different way from what seems probable. It is as small as the smallest known Carboniferous cockroach, but probably of the normal form. The mediastinal area reaches but little beyond the middle of the tegmina and must be narrow. The scapular vein is simple and straight for more than half its length, and only when it reaches the end of the mediastinal area throws out numerous short branches to the margin. The

externomedian vein runs parallel to the scapular and terminates above the apex of the tegmina, emitting numerous inferior, long, straight and parallel, nearly longitudinal branches to the apical margin. The internomedian area is rather narrow, at least in the distal half of the tegmina, subparallel to the inner margin, reaches out as far or nearly as far as the scapular area, and is filled with less crowded, arcuate veins, their convexity apical. The anal area is not preserved.

It is barely possible that what I have here taken for the scapular vein may be an anterior branch of what is regarded as the externomedian, similar to what is found in some of the species of that strange genus *Oryctoblattina*; but the other parts of the tegmina below this are at decided variance with the peculiar characteristics of *Oryctoblattina*, and hardly allow room for the development of the lower veins. If my interpretation of the neuration is correct, *Microblattina* must find a place near *Etoblattina*, but separated from it and its allies by the remarkable fact that the branches of the externomedian vein are inferior and not superior, just as in *Anthracoblattina*, where the mediastinal area is long.

A single species is known, coming from the Rhode Island coal field, which belongs in all probability to the Lowest Productive Coal-measures.

MICROBLATTINA PERDITA sp. nov.

Pl. III, fig. 5.

Unfortunately the basal half of the tegmina of this interesting species is destroyed, but the portion preserved shows that the tegmina were of slender ovate form, probably rather more than two and a half times longer than broad; the costal margin is very gently convex, the inner margin nearly straight, and the tip somewhat broadly rounded. The mediastinal area comes into the preserved fragment just enough to show that it was slender, with short, simple, arcuate branches, and that it reached somewhat beyond the middle of the tegmina, terminating somewhat abruptly. The scapular vein, as soon as it begins to fork (just before the extremity of the mediastinal area), approaches the margin less rapidly, increasing its length so that it extends nearly to the apex of the tegmina and crowds closely against the externomedian; its branches are very closely crowded, arcuate and simple, except for the forked basal branch. The externomedian vein first branches probably not beyond the end of the proximal third of the tegmina, and its parallel and straight branches shorten and become more crowded toward the extremity. Some of them are apically forked, and apparently what appear to be the basal ones, each of which is apically forked, are united at their base. What can be seen of the internomedian area is nearly riband-shaped, the main vein approaching the inner margin very gradually until just before its termination, when it curves down to it much as in the case of the mediastinal vein, and its branches, which are more

distant than those of other parts of the tegmina and mostly simple, take on the arcuation of this apical part of the vein. None of the anal area is preserved. The externomedian vein and its branches, except next the border, appear in strong relief, while all the others are delicately incised, particularly those of the internomedian area. The whole surface is uniformly black and there is no sign of any other sculpture.

Length of fragment, 4 mm.; probable length of tegmina, 8 mm.; breadth, 3 mm.

From the Lower (?) Productive Coal-measures of East Providence R. I.; in the collection of Mr. R. D. Lacoe, No. 2092a.

7. Genus ARCHIMYLACRIS.

Archimylacris Scudd., Daws., Acad. Geol., 2d ed., 388 (1868).

Archimylacris is one of the few genera found in the Millstone Grit as well as later; but, unlike the other genera occurring there, it is at no time a prevailing type, nor does it occur later than the true Productive Coal-measures, nor indeed above its lowest members in the Eastern Interior coal field, in which a single species occurs; the oldest species occurs in the Pennsylvania coal basin, the youngest in the Acadian coal basin. In the light of our present knowledge, therefore, *Archimylacris* may be looked upon as one of the most primitive types of cockroaches, for it has been found in the earliest beds that have yielded these insects, and no generic type has been extinguished at an earlier epoch than it. Of the genera existing as early as the Lowest Productive Coal-measures, all have been recovered in later rocks excepting *Microblattina* and *Necymylacris*, but these two genera are not known, like *Archimylacris*, at a still earlier epoch. The genus has not yet been recognized in the European rocks.

Table of the species of Archimylacris.

- a*¹. Tegmina of nearly equal width throughout; anal area hardly extending beyond the basal third of the tegmina..... 1. *A. parallela*.
- a*². Tegmina oval throughout, nowhere with parallel margins; anal area extending considerably beyond the basal third of the tegmina.
 - b*¹. Tegmina fully two and a half times longer than broad, the mediastinal area distinctly tapering throughout its distal half..... 2. *A. paucinervis*.
 - b*². Tegmina only twice as long as broad, the mediastinal area scarcely tapering before its extreme tip 3. *A. acadica*.

1. ARCHIMYLACRIS PARALLELA.

Archimylacris parallela Scudd., Mem. Bost. Soc. Nat. Hist., III, 85-87, pl. 6, fig. 6 (1879); Foss. Ins. N. A., I, 105-107, pl. 6, fig. 6 (1890).

From Campbell's Ledge, near Pittston, Pa., near the bottom of the Millstone Grit, where it was discovered by Mr. R. D. Lacoe, in whose collection it bears the number 2007. In the original description it was wrongly referred to the Lowest Productive Coal-measures at Cannelton, Pa., and as collected by Mr. Mansfield. The same error is unfortunately repeated in my Fossil Insects of North America and in my Index to Known Fossil Insects (Bull. 71, U. S. Geol. Survey).

2. ARCHIMYLACRIS PAUCINERVIS.

Archimylacris paucinervis Scudd., Mem. Bost. Soc. Nat. Hist., IV, 411-414. pl. 31, fig. 5 (1890); Foss. Ins. N. A., I, 387-390, pl. 23, fig. 5 (1890).

From the Lower Productive Coal-measures at Mazon Creek, Illinois.

3. ARCHIMYLACRIS ACADICA.

Archimylacris acadica Scudd., Daws., Acad. Geol., 2d ed., 388, fig. 153 (1868); Mem. Bost. Soc. Nat. Hist., III, 84-85, pl. 6, figs. 8, 14 (1879); Foss. Ins. N. A., I, 104-105, pl. 6, figs. 8, 14 (1890).

Found in shale overlying the roof of the main seam of coal at the East River, Pictou, Nova Scotia.

8. Genus SPILOBLATTINA.

Spiloblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 35-36 (1885).

So far as known this genus is peculiar to the American Trias, four species occurring in Colorado. It is very closely related to *Etoblattina*, and especially to the species of that genus from the latest Carboniferous deposits with open neurulation, and it is no doubt an offshoot from that genus, which existed side by side with it or comes of similar parentage with it.

Table of the species of Spiloblattina.

- a*¹. Scapular vein as far as its penultimate branch almost completely parallel to the costal margin, not receding from it opposite the middle of the adjoining discal stigma.
- b*¹. Tegmina relatively slender, fully three times as long as broad.
- c*¹. Scapular faintly approaching the externomedian vein to inclose the stigma between them..... 1. *S. gardineri*.
- c*². Scapular in no way approaching the externomedian vein to inclose the stigma between them..... 2. *S. triassica*.
- b*². Tegmina relatively broad, not over two and a half times longer than broad.
3. *S. guttata*.
- a*². Scapular vein distinctly receding from the costal margin opposite the middle of the adjoining discal stigma..... 4. *S. marginata*.

1. SPILOBLATTINA GARDINERI.

Spiloblattina gardineri Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 36 (1885); Mem. Bost. Soc. Nat. Hist., IV, 461-462, pl. 41, figs. 4, 6, 8, 10 (1890); Foss. Ins. N. A., I, 437-438, pl. 33, figs. 4, 6, 8, 10 (1890).

Trias of Fair Play, Colo.

2. SPILOBLATTINA TRIASSICA.

Spiloblattina triassica Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 36 (1885); Mem. Bost. Soc. Nat. Hist., IV, 461, 462-463, pl. 4, fig. 1 (1890); Foss. Ins. N. A., I, 437, 438-439, pl. 33, fig. 1 (1890).

Trias of Fair Play, Colo.

3. SPILOBLATTINA GUTTATA.

Spiloblattina guttata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 36-37 (1885); Mem. Bost. Soc. Nat. Hist., IV, 461, 463, pl. 41, fig. 2, pl. 42, fig. 14 (1890); Foss. Ins. N. A., II, 437, 439, pl. 33, fig. 2, pl. 34, fig. 14 (1890).

Trias of Fair Play, Colo.

4. SPILOBLATTINA MARGINATA.

Spiloblattina marginata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 37 (1885); Mem. Bost. Soc. Nat. Hist., IV, 461, 464, pl. 41, fig. 3 (1890); Foss. Ins. N. A., I, 437, 440, pl. 33, fig. 3, (1890).

Trias of Fair Play, Colo.

9. Genus ETOBLATTINA.

Etolblattina Scudd., Mem. Bost. Soc. Nat. Hist., III, 56-58 (1879); Foss. Ins. N. A., I, 76-78 (1890).

This might be termed the typical genus of Palæoblattariæ, or at least of Blattinariæ, for it was the prevailing type in the Carboniferous and Permian periods, containing very nearly one-half of the known Paleozoic cockroaches, and in America almost exactly one-half. Ninety-seven species have already been recognized—sixty-nine in this country and twenty-eight in Europe—yet a dozen years ago only two species were recognized in this country. The great increase is due to the discovery of the localities at Richmond, Ohio, and Cassville, West Virginia, at which places all but fourteen of the new American species have occurred. Even in the older rocks it holds a predominant position, being there equaled in number only by *Mylacris* in America, while in Europe it has nearly treble the number of species belonging to *Gerablattina* or *Anthracoblattina*, its nearest numerical neighbors. Its number in America is also treble, or a little more than treble, that of *Gerablattina*, which follows it among Blattinariæ. Not a single species is common to Europe and America, nor in America has a single one been certainly found at two distinct localities.

In accordance with the fact of its predominance is that of its endurance, since in this country it has been recognized in every deposit which has yielded remains of cockroaches, from the Millstone Grit, where a single species occurs in the Western Interior coal field,¹ to the Trias, from which, in Colorado, two species have been recognized. This can not be said of any other genus of cockroaches. It reaches its culmination in the Permian, where it is found in astonishing abundance in the Dunkard Creek series of West Virginia, whence thirty-six species are known from the single locality of Cassville, Monongalia County. Every coal basin in this country from which cockroaches are known, except the Acadian, has furnished some species of this genus. In the true Productive Coal-measures they have been found most abundantly in the

¹This refers to *E. venusta*, found by Lesquereux in Arkansas deposits regarded by him as of this age, but according to the latest surveys it is more probable, Mr. Lacoe informs me, that the deposits belong to the Lower Productive Coal-measures, in which case the above statement must be modified.

Rhode Island basin (eight species); but in the Barren Coal-measures of eastern Ohio seventeen species occur, which is a number larger than that of all the species from the Productive Coal-measures from all American localities combined, indicating the ascendancy of the group.

At the same time, the deposits of the Barren Coal-measures and of the Permian rocks present a new type, already referred to in the Introduction and pretty easily recognized at a glance by the slenderness of the tegmina combined with an exceptional openness of the neuration in the middle of the tegmina, the latter feature somewhat recalling the Triassic *Spiloblattina*, though with a slightly different effect. So far as the present material shows, this type was the prevailing one in the Barren Coal-measures of this country, but seems to have been only less prevalent in the Permian. It was not peculiar to America, for it appears in the European Permian species, *E. elongata*. I have not attempted, as perhaps I should have done, to bring all these species together in the following table, but they are grouped to a certain extent in a subordinate manner.

In Europe, also, *Etolblattina* was the predominating type of cockroaches and has been found in every successive series of rocks in which cockroaches have been found, from the Lowest Productive Coal-measures to the Permian. It seems to have reached its climax in the upper Carboniferous deposits, corresponding largely to our Barren Coal-measures. For assistance in studying the European forms, I have added in the Introduction a section upon the European species of the genus, with a key for their determination.

The following table has been constructed with much difficulty; and while it brings in juxtaposition many of the nearly allied species in a natural manner, it separates at the same time whole series, which a more complete knowledge of the neuration from more perfect examples would have enabled me to arrange in a better order by their judicious mingling. It is offered only as a temporary convenience. The sequence of the species in the table is followed in the text and as far as possible in the plates.

Table of the species of Etoblattina.

- a*¹. Relatively broad species; tegmina distinctly less than two and one-half times longer than broad.
- b*¹. Mediastinal area less than two-thirds the length of the tegmina.
- c*¹. Internomedian area terminating far short of the apex of the tegmina.
- d*¹. Mediastinal area triangular, continuously tapering, reaching only the middle or a little beyond the middle of the tegmina.
- e*¹. Scapular vein terminating at the very apex of the tegmina; externomedian vein first forking beyond the middle of the tegmina.
 - 1. *E. clintoniana*.
- e*². Scapular vein terminating before the extreme apex of the tegmina; externomedian vein first forking far before the middle of the tegmina..... 2. *E. lata*.
- d*². Mediastinal area vittate, tapering only at extremity, reaching far beyond the middle of the tegmina.

Table of the species of Etblattina—Continued.

- e*¹. Externomedian vein first forking at about the middle of the tegmina, the branches mostly simple..... 3. *E. sagittaria*.
- e*². Externomedian vein first forking near the end of the proximal third of the tegmina, the branches mostly forked.... 4. *E. mediana*.
- c*². Internomedian area nearly reaching the tip of the tegmina.
 - d*¹. Tegmina only twice as long as broad; veins rather numerous. 5. *E. fossa*.
 - d*². Tegmina much more than twice as long as broad; veins very numerous.
 - e*¹. Large species, the tegmina exceeding 50 mm. in length; mediastinal area reaching far beyond the middle of the tegmina. 6. *E. illustris*.
 - e*². Small species, the tegmina less than 12 mm. long; mediastinal area only extending to the middle of the tegmina..... 7. *E. ovata*.
- b*². Mediastinal area at least two-thirds as long as the tegmina.
 - c*¹. Tegmina only twice as long as broad; mediastinal area not more than two-thirds as long as the tegmina..... 8. *E. scholfieldi*.
 - c*². Tegmina considerably more than twice as long as broad; mediastinal area nearly or quite three-fourths as long as the tegmina.
 - d*¹. Internomedian area terminating far before the tip of the tegmina.
 - e*¹. Scapular and externomedian veins nearly united in basal third of tegmina; internomedian vein normal 9. *E. debilis*.
 - e*². Scapular and externomedian veins clearly distinct throughout; internomedian vein peculiar.
 - f*¹. Externomedian vein simple, unbranched; internomedian vein reinforced by a supplementary branched superior stem. 10. *E. strigosa*.
 - f*². Externomedian vein abundantly branched; internomedian vein very strongly sinuate, the area apically very slender. 11. *E. clarkii*.
 - d*². Internomedian area extending nearly to the tip of the tegmina,
 - 12. *E. venusta*.
- a*². Relatively slender species, the tegmina two and one-half or more times longer than broad.¹
 - b*¹. Tegmina distinctly less than three times as long as broad.
 - c*¹. Internomedian area not or hardly attaining the apical margin.
 - d*¹. Veins in center of tegmina much more widely separated than those on the apical margin.
 - e*¹. Mediastinal area considerably more than two-thirds the length of the tegmina.
 - f*¹. Internomedian branches distant and most of them forked.
 - 13. *E. balteata*.
 - f*². Internomedian branches crowded and most of them simple.
 - 14. *E. patiens*.
 - e*². Mediastinal area somewhat or distinctly less than two-thirds the length of the tegmina.
 - f*¹. Scapular and externomedian veins first branching at very unequal distances from the base.
 - g*¹. Externomedian and internomedian branches very crowded, more so than the branches of the other veins..... 15. *E. mucronata*.
 - g*². Externomedian and internomedian branches, especially the latter, not crowded, and not more so than the others. 16. *E. detecta*.
 - f*². Scapular and externomedian veins first forking side by side.
 - 17. *E. occidentalis*.
 - d*². Veins in center of tegmina scarcely more widely separated than those on the apical margin.

¹In a few species the tegmina are barely two and one-half times, in a few others they are more than three times longer than broad.

Table of the species of Etoblattina—Continued.

- e*¹. Mediastinal area less than three-fifths the length of the tegmina.
- f*¹. Tegmina sparsely veined..... 18. *E. exigua*.
- f*². Tegmina abundantly veined.
- g*¹. Main scapular vein nearly straight..... 19. *E. sp.* (R. I.).
- g*². Main scapular vein strongly arcuate.
- h*¹. Scapular vein subparallel to the costal margin in the basal half of the tegmina; its branches oblique..... 20. *E. jeffersoniana*.
- h*². Scapular vein forming a considerable angle with the costal margin in the basal half of the tegmina, its branches longitudinal 21. *E. residua*.
- e*². Mediastinal area more than three-fifths the length of the tegmina.
- f*¹. Anal furrow terminating hardly or not beyond the end of the proximal two-fifths of the tegmina.
- g*¹. Veins of internomedian area not crowded; scapular and externomedian veins well separated from the base .. 22. *E. funeraria*.
- g*². Veins of internomedian area crowded; scapular and externomedian veins united in the proximal fourth of the tegmina.
23. *E. expuncta*.
- f*². Anal furrow terminating scarcely short of the middle of the tegmina.
24. *E. gorhami*.
- c*². Internomedian area distinctly attaining the apical margin.
- d*¹. Veins in center of tegmina widely separated.
- e*¹. Mediastinal area less or scarcely more than one-half the length of the tegmina.
- f*¹. Internomedian vein nearly straight, nearly all the branches simple.
- g*¹. Internomedian area narrow, in the middle less than one-fourth the width of the tegmina..... 25. *E. aperta*.
- g*². Internomedian area relatively broad, in the middle nearly one-third the width of the tegmina..... 26. *E. fasciata*.
- f*². Internomedian vein strongly sinuate, many of the branches forked, often doubly forked.
- g*¹. Mediastinal vein arcuate beyond base; scapular vein scarcely bent at the origin of the first two branches 27. *E. ramosa*.
- g*². Mediastinal vein straight beyond base; scapular vein distinctly bent at the origin of the first two branches 28. *E. willsiana*.
- e*². Mediastinal area nearly or quite three-fifths the length of the tegmina.
- f*¹. Externomedian vein first branching close to the middle of the tegmina.
- g*¹. Internomedian vein arcuate throughout, continually approaching the margin..... 29. *E. lesquereuxii*.
- g*². Internomedian vein sinuous by a distinct apical extension, subparallel to the margin.
- h*¹. The branches of the mediastinal vein mostly originate from the vein itself.
- i*¹. Main scapular vein broadly sinuate; internomedian vein nearly reaching the very apex of the tegmina.
- j*¹. Costal margin broadly arcuate; first two branches of scapular vein widely separated at origin..... 30. *E. maledicta*.
- j*². Costal margin strongly arcuate; first two branches of scapular vein closely approximate at base..... 31. *E. benedicta*.
- i*². Main scapular vein rigidly straight through most of its course; internomedian vein falling considerably short of the apex.
32. *E. funesta*.
- h*². Most of the branches of the mediastinal vein arise from its first branch, which imitates the mediastinal vein. 33. *E. exsensa*.

Table of the species of Etoblattina—Continued.

- f*². Externomedian vein first branching well within the proximal half of the tegmina.
- g*¹. Mediastinal vein about three-fifths the length of the tegmina; scapular vein forking before the externomedian vein. 34. *E. tenuis*.
- g*². Mediastinal vein two-thirds the length of the tegmina; externomedian vein forking before the scapular vein. 35. *E. hustoni*.
- d*². Veins in center of tegmina not widely separated.
- e*¹. Mediastinal area distinctly less than two-thirds the length of the tegmina.
- f*¹. Anal furrow striking the margin not beyond the end of the proximal third of the tegmina.
- g*¹. Internomedian area more than one-third the breadth of the tegmina in the middle of their distal half. 36. *E. persistens*.
- g*². Internomedian area less than one-third the breadth of the tegmina in the middle of their distal half. 37. *E. eakiniana*.
- f*². Anal furrow striking the margin but little before the middle of the tegmina.
- g*¹. Small species; tegmina with strongly convex costa; externomedian vein first branching before the tip of the anal furrow and well before the middle of the tegmina. 38. *E. accubita*.
- g*². Large species; tegmina with gently convex costa; externomedian vein first branching beyond the tip of the anal furrow and scarcely before the middle of the tegmina. 39. *E. mazona*.
- e*². Mediastinal area fully two-thirds the length of the tegmina.
- f*¹. Scapular vein first forking scarcely before the externomedian vein.
- g*¹. Mediastinal area scarcely if any more than two-thirds the length of the tegmina.
- h*¹. Internomedian area reaching the apex of the tegmina by the retroarcuation of the main vein. 40. *E. expulsata*.
- h*². Internomedian area reaching only the extreme limit of the apical margin of the tegmina, without noticeable retroarcuation.
- i*¹. Mediastinal branches excessively longitudinal and crowded; scapular branches mostly forked. 41. *E. gratiosa*.
- i*². Mediastinal branches normal and not crowded; scapular branches all simple. 42. *E. macerata*.
- g*². Mediastinal area almost or quite three-fourths the length of the tegmina. 43. *E. immolata*.
- f*¹. Scapular vein first forking at a noticeable distance before the externomedian vein.
- g*¹. Anal furrow striking the margin scarcely beyond the end of the proximal two-fifths of the tegmina.
- h*¹. Mediastinal area three-fourths the length of the tegmina, tapering rather abruptly. 44. *E. mactata*.
- h*². Mediastinal area scarcely if any more than two-thirds the length of the tegmina, tapering gently. 45. *E. communis*.
- g*². Anal furrow striking the margin scarcely before the middle of the tegmina. 46. *E. sp.* (Colo.).
- b*². Tegmina almost or fully three times as long as broad.
- c*¹. Mediastinal area less than two-thirds the length of the tegmina.
- d*¹. Internomedian vein more or less, often considerably, sinuate, much of the apical portion nearly or quite parallel to the inner margin, and rarely falling at all short of the apex of the tegmina.

Table of the species of Etoblattina—Continued.

- e*¹. Scapular vein forking before, generally long before, the externomedian; anal area normal.
- f*¹. Mediastinal area less than half as long as the tegmina. 47. *E. hastata*.
- f*². Mediastinal area more than half as long as the tegmina.
- g*¹. Costal margin nearly straight throughout the middle half¹.
- h*¹. Internomedian area scarcely narrowing in its proximal half. 48. *E. marginata*.
- h*². Internomedian area rapidly narrowing in its proximal half. 49. *E. gracilentia*.
- g*². Costal margin regularly arcuate throughout..... 50. *E. exsecuta*.
- e*². Scapular vein first forking later than the externomedian; anal area exceptionally long and narrow..... 51. *E. arcta*.
- d*². Internomedian vein nearly or quite straight, the area tapering almost regularly and falling considerably, sometimes far, short of the apex of the tegmina.
- e*¹. Internomedian vein terminating well beyond the middle of the distal half of the tegmina.
- f*¹. Main scapular vein strongly sinuous..... 52. *E. stipata*.
- f*². Main scapular vein nearly straight throughout.
- g*¹. Anal furrow striking the inner margin well beyond the end of the proximal third of the tegmina..... 53. *E. prædulcis*.
- g*². Anal furrow striking the inner margin far before the end of the proximal third of the tegmina..... 54. *E. variegata*.
- e*². Internomedian vein terminating at or before the middle of the distal half of the tegmina.
- f*¹. Externomedian vein strongly bent where first forked and thereafter very oblique..... 55. *E. hilliana*.
- f*². Externomedian vein gently bent where first forked and thereafter but little or scarcely oblique.
- g*¹. Tegmina scarcely tapering apically before the distal fourth, nearly equal in the middle half; internomedian area extending but little further than the mediastinal.
- h*¹. Tegmina more than three times as long as broad; internomedian area exceptionally narrow; externomedian vein first branching but little beyond the tip of the anal furrow. 56. *E. angusta*.
- h*². Tegmina less than three times as long as broad; internomedian area of normal breadth; externomedian vein first branching well beyond the tip of the areal furrow.... 57. *E. macilentia*.
- g*². Tegmina tapering from the middle, the middle half fusiform; internomedian area extending very much farther than the mediastinal.
- h*¹. Internomedian area in middle less than one-third the breadth of tegmina; anal area excessively slender..... 58. *E. exilis*.
- h*². Internomedian area in middle more than one-third the breadth of the tegmina; anal area normal..... 59. *E. rogi*.
- c*². Mediastinal area more than two-thirds the length of the tegmina.
- d*¹. Internomedian vein reaching nearly or quite to the apical margin of the tegmina.
- e*¹. Main veins separated in the center of the tegmina by hardly wider intervals than the branches near the apical margin.
- f*¹. Scapular and externomedian veins distinct throughout.

¹ This is not clear, but probable, in *E. marginata*.

Table of the species of Etoblattina—Continued.

- g*¹. Internomedian area just failing to reach the apical margin.
*h*¹. Mediastinal branches not crowded; internomedian branches rarely forked; anal area elongate..... 60. *E. expugnata*.
*h*². Mediastinal branches crowded, internomedian branches mostly forked; anal area abbreviate 61. *E. obatra*.
*g*². Internomedian area distinctly reaching the apical margin.
*h*¹. Mediastinal branches crowded, mostly forked; scapular and externomedian veins first forking close together
62. *E. imperfecta*.
*h*². Mediastinal branches not crowded, rarely forked; scapular vein first forking well before the externomedian.. 63. *E. secreta*.
*f*². Scapular and externomedian veins united in basal fourth or more of the tegmina 64. *E. reliqua*.
*e*². Main veins separated in the center of the tegmina by much wider intervals than the branches near the apical margin.
*f*¹. Scapular and externomedian veins both first forking in the distal half of the tegmina..... 65. *E. invisa*.
*f*². Scapular and externomedian veins both first forking well within the proximal half of the tegmina.
*g*¹. Externomedian vein distinctly oblique, the branches distinctly superior.
*h*¹. Internomedian vein strongly sinuate, curving just beyond the anal furrow in an opposite sense to it 66. *E. occulta*.
*h*². Internomedian vein arcuate almost to the tip.... 67. *E. latebricola*.
*g*². Externomedian vein longitudinal, the branches purely furcate and longitudinal..... 68. *E. defossa*.
*d*². Internomedian vein falling distinctly short of the apical margin of the tegmina 69. *E. recidiva*.

The hind wings described in the following list are not included in the table, nor is the fragment shown on Pl. XII, fig. 2.

1. ETOBLATTINA CLINTONIANA sp. nov.

Pl. IV, fig. 1

Tegmina broad subovate, two and a quarter times as long as broad, the costal margin beyond the well-shouldered base very faintly convex, the anal area full, and beyond it the inner margin symmetrical with the costal; the apex well rounded. Mediastinal area triangular, rapidly tapering, terminating before the middle of the tegmina and slightly before the tip of the anal furrow; the vein has only three or four simple, nearly straight, very oblique branches. The scapular vein runs subparallel to and distant from the costal margin nearly through the middle of the tegmina, straight in the greater part of its course, but arcuate in opposite senses at the two extremities, terminating exactly at the apex of the tegmina; it first forks as far toward the base as the internomedian vein, and has about eight gently arcuate branches, mostly simple, but others more or less deeply or doubly forked, all very oblique and the distal ones sublongitudinal. The externomedian vein runs parallel to the preceding, diverging but little

from it when, beyond the middle of the tegmina, it first branches and is unimportant, having but a couple of branches, one simple, the other forked. The internomedian vein is gently arcuate, runs parallel to the externomedian and strikes the inner margin just before the distal tenth of the tegmina; it has five or six mostly simple sweeping branches. The anal furrow is rather strongly impressed, very regularly and strongly arcuate, and nearly reaches the middle of the tegmina; the anal veins are numerous, arcuate, crowded, mostly simple, and avoid the space adjoining the anal furrow.

Length of tegmina, 22.5 mm.; breadth at anal furrow, 10 mm. (broader at the middle of the anal area).

The surface of the tegmina, especially in the distal half and in the internomedian area, is covered by very delicate cross lines between the nervures, not very closely crowded.

This species, represented by a nearly perfect fore wing, is more nearly allied to the European *E. primavera* than to any of ours; it is about two-thirds its size and differs in its lesser breadth, the greater brevity of the mediastinal area, and the far later forking of the externomedian vein.

From the Lowest Productive Coal-measures at Gilkerston Ford, near Clinton, Mo., collected by David White, United States Geological Survey. No. 2182; original No. 412.

2. ETOBLATTINA LATA sp. nov.

Pl. IV, fig. 2.

Although the only known specimen of this species is imperfect by the loss of both extremities of the tegmina, they are apparently a little less than two and a half times as long as broad, the costal margin rather gently convex, the inner margin straight, and the apex well rounded. The mediastinal area is distinctly triangular and tapering throughout, terminating shortly before the distal end of the middle fifth of the tegmina, with few and distant, straight, very oblique, simple or forked branches. The scapular vein is broadly sinuate throughout, terminates at a little distance before the extreme apex of the tegmina, first branches within the basal fourth of the tegmina, and has about five nearly longitudinal, simple, forked, or doubly forked branches. The externomedian vein is also broadly sinuate, first forks opposite the tip of the anal furrow, and has four or more longitudinal, gently arcuate, simple or forked branches occupying the apical margin. The internomedian vein is feebly sinuate and probably terminates well before the extreme apex of the tegmina, and has six or seven mostly simple, strongly oblique, nearly straight branches, the first of which, deeply forked, originates far before the others, close to the very base of the vein. The anal furrow is deeply impressed, bent arcuate, and strikes the inner margin at about the end of the proximal third of

the tegmina; the anal veins are simple, very gently arcuate, and subequidistant. The anal and internomedian veins are finely traced in black on the surface of the tegmina, otherwise of the color of the dark stone; and there are straight and crowded delicate cross lines between all the nervures.

Length of fragment, 10.5 mm.; probable length of tegmina, 16 mm.; breadth, 6.75 mm.

This species is most nearly allied to *E. sagittaria*, a considerably larger species, but differs from it in the form of the tegmina, the triangular and not vittate form of the mediastinal area, the far earlier branching of the externomedian vein, and the considerable difference in the character of the internomedian area.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; No. 2099a.

3. ETOBLATTINA SAGITTARIA sp. nov.

Pl. IV, fig. 3.

The tegmina are twice as long as broad, have an ovate form, tapering rather regularly from about the middle of the anal area, with subacuminate rounded apex; the costal margin is gently arcuate, as is also the distal half of the inner margin. The mediastinal area is narrow, in its middle hardly a fifth the breadth of the tegmina, and ends with the middle fifth of the same; its branches are few, distant, simple, straight, and oblique. Scapular vein gently sinuate, subparallel to the inner margin and terminating almost at the very apex of the tegmina; it has five branches, the first arising within the proximal fourth of the tegmina, the second about the middle of the tegmina, these two forked or doubly forked, the remainder arising at regular intervals and simple; all are longitudinally oblique and gently arcuate. The externomedian vein is strongly sinuate, especially arcuate at base, first forks about the middle of the tegmina and has from three to five simple or forked, straight, longitudinal branches, arising at equal intervals in the distal half of the tegmina. The internomedian vein is strongly sinuate, parallel to the preceding but slightly approaching it distally, where the area is prolonged and attenuated, reaching the distal fifth of the tegmina; the seven or eight branches are mostly simple, slightly arcuate and oblique, the distal branches more strongly than the basal. The anal furrow is feebly impressed, very regularly and strongly arcuate and strikes the inner margin just beyond the end of the proximal two-fifths of the tegmina; the anal branches are few, subequidistant, arcuate, and simple. The surface of the tegmina shows no sign of cross-lining.

Length of preserved portion of tegmina, 11 mm.; probable length of tegmina, 12.8 mm.; breadth, 6.5 mm.

In its form and the apically attenuate internomedian area this species closely resembles *E. deanensis* of England, but differs strikingly from

it in both the mediastinal and externomedian areas. It nevertheless appears to be closer to that than to any other European species, though it more nearly approaches our *E. mediana*. Were it not for the apical attenuation of the internomedian area, it would bear a strong resemblance to a *Petrablattina*, on account of the simplicity and longitudinality of its straight externomedian branches.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; four specimens, Nos. 2100 *a, b, c, d*.

4. ETOBLATTINA MEDIANA.

Pl. IV, fig. 4.

Tegmina somewhat less than two and one-half times as long as broad, tapering rather rapidly on apical half, subacuminate at apex, the costal margin rather strongly arcuate, the inner margin nearly straight to the end of the internomedian area and then rapidly arcuate. Mediastinal area vittate, terminating at the distal end of the middle fifth of the tegmina with somewhat distant, nearly straight, strongly oblique, mostly simple branches. Scapular vein gently arcuate beyond the base, terminating well short of the apex of the tegmina, with only three distant inequidistant branches, the first arising far toward the base, apically doubly forked, the next near the middle of the tegmina and deeply forked, the third simple. The externomedian vein is of unusual importance and has a sinuous course to make room for the apical extension of the following vein; it first forks not far beyond the middle of the proximal half of the tegmina and has four inequidistant, apically arcuate branches, which fork at unequal distances from the margin, the last simple. The internomedian vein is sinuate by the apical extension of its attenuated tip and reaches to the distal fifth of the tegmina; its branches are few, distant, arcuate, simple or deeply forked, the proximal oblique, the distal nearly longitudinal. The anal furrow is very feebly impressed, greatly arcuate, and strikes the inner margin not far beyond the end of the proximal fourth of the tegmina; the anal area is not preserved. The surface of the tegmina is marked with closely crowded delicate cross lines between the nervures, and the latter are faintly and finely traced in black. The basal third of the tegmina is lost in the single specimen known.

Length of fragment, 12 mm.; probable length of tegmina, 17 mm.; breadth, 7.5 mm.

This species differ from *E. sagittaria* by the far greater importance of the externomedian area, but seems to be more nearly allied to it than to any other species.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; No. 2101 *a-b*.

5. *ETOBLATTINA FOSSA* sp. nov.

Pl. IV, fig. 5.

Tegmina scarcely more than twice as long as broad, the inner margin nearly straight, the costal rather strongly convex, the apex broadly rounded. Mediastinal area broad at base, rapidly narrowing beyond the middle, terminating just beyond the middle of the tegmina; the branches few, mostly simple, straight and very oblique. Scapular vein strongly sinuate, in the middle subparallel to the costal margin, terminating close to the apical margin, first branching in the middle of the proximal half of the tegmina, with few gently arcuate branches, but the proximal ones deeply forked or compound, and all longitudinally oblique. Externomedian vein rather strongly sinuate, first branching a little before the middle of the tegmina, the branches few but mostly doubly forked and longitudinally arcuate. Internomedian vein parallel to the externomedian, terminating a little before the extreme apex of the tegmina, two branches which are doubly forked thrown off in the proximal fourth of the tegmina, and only one or two (simple?) beyond. Anal furrow finely impressed, regularly arcuate but apically straight and nearly transverse, terminating beyond the proximal two-fifths of the tegmina. The surface is glistening, carbonaceous, and distinctly marked with crowded and very irregular delicate cross lines, in places becoming reticulate. The lower part of the tip of the tegmina is broken off from the only specimen known, and the shoulder of the base is lost, with the anal area.

Length of fragment, 12.4 mm.; probable length of tegmina, 14 mm.; breadth, 6.75 mm.

This species closely resembles the next two, but the neuration is much less close, and the branching of the internomedian vein very different, most of the area being taken up with the offshoots of the first two branches.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston, No. 182.

6. *ETOBLATTINA ILLUSTRIS*.

Pl. IV, fig. 11.

Etblattina illustris Scudd., Bull. U. S. Geol. Surv., No. 101, 12-13, pl. 2i (1893).

From the Lower (?) Productive Coal-measures of Pawtucket (?), R. I.

7. *ETOBLATTINA OVATA* sp. nov.

Pl. IV, fig. 6.

Tegmina of a very symmetrical long ovate form, somewhat more than twice as long as broad. Mediastinal area fully half as long as the tegmina, the branches of the vein not numerous, gently arcuate, and mostly simple. Scapular vein nearly straight, with only a gentle arcua-

tion at the extremities, subparallel to the costal margin and terminating scarcely before the extreme apex of the tegmina; it first branches in the middle of the proximal half of the tegmina, and has half a dozen very oblique and straight branches, simple or doubly forked. Externomedian vein straight and longitudinally oblique in its middle half, but arcuate at the extremities, terminating a little below the apex of the tegmina, thus occupying but an inconsiderable space on the margin; in the single specimen before me it first forks a little before the middle of the tegmina and has four branches, but the first is blind, the second deeply forked, the others simple, and all longitudinal. The internomedian vein is broadly sinuate, especially by the apical prolongation of the area, nearly to the apex of the tegmina, and is supplied with numerous branches, all, so far as can be seen, simple and arcuate, the proximal oblique, the distal longitudinal. The anal furrow is rather deeply impressed, strongly arcuate and probably mesially bent, terminating a little before the middle of the tegmina; the anal veins are numerous and crowded, strongly arcuate, and most of them very deeply forked. The carbonaceous black surface is indistinctly marked with rather close and irregular tremulous cross lines.

Length of fragment, 13 mm.; probable length of tegmina, 14.5 mm.; breadth, 6.25 mm.

This species is tolerably distinct from any of the known species of *Etolblattina*, but is perhaps most nearly allied to *E. illustris*, from which it differs in every known point of structure, and in particular in its feebly developed externomedian area, not to mention the extreme disparity in size, the present species having tegmina less than one-fifth as long as *E. illustris*.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2102a.

8. ETOBLATTINA SCHOLFIELDI.

Pl. IV, fig 7.

Etolblattina scholfieldi Scudd., Bull. U. S. Geol. Surv., No. 101, 15, pl. 2, fig. b (1893).

From the Lower (?) Productive Coal-measures of East Providence, R. I.

9. ETOBLATTINA DEBILIS sp. nov.

Pl. IV, fig. 8.

Tegmina oval, tapering from before the middle, about two and one-fourth times longer than broad, the costal border strongly convex, especially in basal half, the inner margin nearly straight, except at base and apex, and the apex probably well rounded. Mediastinal area vittate, about a fourth of the width of the tegmina, apically tapering gradually, and terminating scarcely beyond the distal end of the middle third of the tegmina, the branches tolerably numerous, straight, oblique or very oblique, and rarely forked. The scapular and externomedian veins run

so closely together in the proximal fourth of the tegmina as often with difficulty to be distinguished; beyond this the former is nearly straight and ends scarcely above the extreme apex of the tegmina; the branches are simple or deeply forked, nearly straight and oblique, the first originating sometimes as early as the middle of the proximal half of the tegmina. The externomedian vein, nearly as soon as it distinctly parts from the scapular, is straight and longitudinally oblique with three or four simple or forked straight branches parallel to the scapular vein. The internomedian vein is strongly arcuate at base, straight beyond, and terminates not far from the middle of the distal half of the tegmina; its branches are only three or four in number, but they are often deeply forked or doubly forked, nearly straight, and with a general oblique course. The anal furrow is very sharply depressed, very strongly arcuate before the straight apex, which strikes the inner margin at the end of the proximal two-fifths of the tegmina; the anal veins next the furrow are bent arcuate, the distant ones oblique and nearly straight, all simple, and the latter much more crowded than the former. The basal portion of the mediastinal vein is almost as much impressed as the anal furrow, and the interval between it and the scapular vein at the extreme base of the tegmina roundly ridged. The surface of the tegmina is of the color of the stone, but the internomedian and anal veins are finely traced in black; excessively crowded fine cross lining appears everywhere between the nervures, especially in the faintly vaulted anal area.

Length of largest fragment, 13 mm.; probable length of tegmina, 17 mm.; breadth, 7.5 mm.

This species somewhat resembles *E. strigosa*, especially in the close basal alliance of the scapular and externomedian veins, but it differs considerably from any species with which one would be disposed to compare it. One of the specimens (No. 2103 *c-d*) does not have the scapular and externomedian veins united to so great a distance as described.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; three specimens, Nos. 2103 *a-b, c-d, e*.

10. ETOBLATTINA STRIGOSA.

Pl. IV, fig. 10.

Etblattina strigosa Scudd., Proc. Bost. Soc. Nat. Hist., XXIV, 52-53 (1889).

From the Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone in the valley of Wills Creek, Richmond, Jefferson County.

11. ETOBLATTINA CLARKII.

Pl. V, fig. 10.

Etblattina clarkii Scudd., Bull. U. S. Geol. Surv., No. 101, 14-15, pl. 2, fig. *j* (1893).

From the Lower (?) Productive Coal-measures at Pawtucket, R. I.

12. ETOBLATTINA VENUSTA.

Blattina venusta Lesq., Second Rep. Geol. Ark., 314, pl. 5, fig. 11 (1860).

Etolblattina venusta Scudd., Mem. Bost. Soc. Nat. Hist., III, 70-72, pl. 6, fig. 12 (1879);

Foss. Ins. N. A., I, 90-92, pl. 6, fig. 12 (1890).

Frog Bayou, Arkansas, in deposits regarded by Lesquereux¹ as having from 200 to 300 feet of Millstone Grit above them, but which I am informed by Mr. R. D. Lacoe, basing his judgment upon the maps and reports of the later Arkansas surveys, more probably belong to the true Productive Coal-measures, or the upper "coal-bearing division" of Winslow. Final reports on the district have not yet been published, and another season's fieldwork may be required to furnish a complete demonstration. In the present paper I have assumed provisionally the accuracy of Lesquereux's determination, though the presumption is not in its favor.

13. ETOBLATTINA BALTEATA.

Gerablattina balteata Scudd., Mem. Bost. Soc. Nat. Hist., III, 110-112, pl. 6, figs. 9,

10 (1879); Rep. Second Geol. Surv. Penn. PP, 104, pl. 38, figs. 5, 5a (1880); Foss.

Ins. N. A., I, 130-132, pl. 6, figs. 9, 10 (1890).

Etolblattina balteata Scudd., Proc. Bost. Soc. Nat. Hist. XXIV, 46, 48 (1889).

From the Waynesburg coal (Lower Permian) of Cassville, W. Va.; and perhaps from Bellaire, Ohio, in the Barren Coal-measures in shales 20 feet below the Pittsburgh coal.

The type of the species comes from Cassville. The fragment from Bellaire is composed of the anal area only, and it is quite impossible to tell whether it belongs to this or an allied species.

14. ETOBLATTINA PATIENS sp. nov.

Pl. IV, fig. 9.

Tegmina slender, nearly three times as long as broad, the costal margin not very strongly but very regularly arcuate, the inner margin nearly straight, the apex probably well rounded, tapering from the middle of the tegmina. Mediastinal area vittate, the vein parallel to the margin, apically tapering and reaching nearly to the middle of the distal half of the tegmina, the branches moderately numerous, oblique, straight, and simple. The scapular vein is unusually straight and terminates scarcely above the extreme apex of the tegmina; it divides in the middle of the proximal half of the tegmina into two longitudinal branches, each further subdivided only beyond the middle of the tegmina, the upper or first branch into a double fork, simulating the appearance of the apical part of the mediastinal vein, the lower or main stem with several inequidistant branches, some at least probably forked. Externomedian vein also very straight and longitudinally oblique, first forking before the middle of the tegmina, the branches distant, only

¹See Geol. Mag., V, 177 (1868).

three or four in number, the first two oblique, the others compound. Internomedian vein similarly straight, though probably a little arcuate at tip (where it is broken in the only specimen seen), terminating probably a little before the apical margin of the tegmina, the branches rather numerous, subequidistant, increasingly oblique the farther from the anal area, arcuate and simple. Anal furrow delicately impressed, not greatly arcuate, terminating at the distal end of the proximal two-fifths of the tegmina. The surface of the tegmina is very broadly banded with black along the veins, between which run rather closely crowded, delicate, irregular cross lines, conspicuous only in the blackened portions.

Length of fragment, 13 mm.; probable length of tegmina, 18 mm.; breadth, 6.4 mm.

This species is closely allied to *E. balteata*, from which it differs principally in the far more numerous and simple internomedian branches, and in the earlier forking of the scapular vein; it is also related not distantly to the European *E. russoma* and probably has the apex, as there, well filled with numerous veinlets, but the costal margin is far less arcuate, and the main veins in *E. russoma* are not nearly so straight as here. It also shows many points of resemblance to our *E. occulta*.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2104 *a-b*.

15. ETOBLATTINA MUCRONATA sp. nov.

Pl. V, fig. 3.

A large part of the base is lost from the only specimen of this species seen, but the tegmina are apparently somewhat less than three times as long as broad, of a lanceolate form, the apical half tapering somewhat rapidly and regularly, the apex subacuminate and sharply rounded. The mediastinal area is triangular, apically attenuate, reaching nearly to the distal end of the middle fifth of the tegmina, first forking at about the end of the proximal third of the tegmina, with three or four arcuate, longitudinally oblique, deeply forked or doubly forked branches, the apical branch simple. Externomedian vein very feebly sinuate, first forking at about the middle of the tegmina, with four branches having a course similar to that of the scapular branches, simple or forked, the last multiforked. Internomedian vein very feebly sinuate, almost straight, terminating well before the apex, but at the edge of the apical margin, with very numerous, nearly straight, crowded, simple, oblique branches. The surface of the tegmina is uniformly blackish, with the feeblest possible signs of distant straight cross lines between the nervures. The anal area and furrows are lost.

Length of fragment, 9.5 mm.; probable length of tegmina, 13.5 mm.; breadth, 5 mm.

This species bears a certain resemblance to *E. expuncta*, but is of much slenderer form, more tapering apically, and has more oblique and more

complicated externomedian branches; the internomedian area is also longer in the present species; besides which there is in *E. expuncta* no such wide separation of the nervures in the middle of the wing as here.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; No. 2105 *a-b*.

16. ETOBLATTINA DETECTA sp. nov.

Pl. IV. figs. 12, 13.

Tegmina long ovate, considerably less than three times as long as broad, with the costal margin very strongly arcuate at base, nearly straight beyond the proximal third of the tegmina, the inner margin nearly straight, and the apex subacuminate, falling above the middle line of the tegmina. The mediastinal area is very slender and tapering, terminating well before the distal end of the middle third of the tegmina, with few very oblique, straight, simple branches. Scapular vein nearly straight, terminating near the beginning of the apical margin, first forking well before the middle of the tegmina with about four very inequidistant, longitudinal or longitudinally oblique, simple or deeply forked, sometimes doubly forked, straight or slightly arcuate branches. Internomedian vein distant from the externomedian, straight or sinuate, terminating at about the middle of the distal half of the tegmina with generally simple, rather distant, parallel, oblique, arcuate branches. Anal furrow very strongly and very regularly arcuate, rather deeply impressed, terminating not far from the middle of the proximal half of the tegmina; anal veins irregularly arcuate, inequidistant and subparallel, simple and moderately numerous. The surface of the tegmina is heavily banded with black along the nervures, so broadly as often to blend with the neighboring bands, and the interspaces are traversed pretty regularly and closely with distinct straight cross lines.

Length of tegmina, 16.5 mm.; breadth, 6.25 mm.

Two specimens are before me which differ considerably in the internomedian vein, which in one is straight and apically divaricate from the externomedian vein, and this latter forks relatively far from the base, while in the other specimen the internomedian vein is sinuous, apically convergent with the externomedian vein, and this latter forks relatively near the base. The latter specimen is nearly perfect; the former has lost a little of both base and apex.

This species is more nearly allied to the two preceding than to any others known to me, but is sufficiently distinguished from *E. mucronata* by its form and the relatively small number of internomedian branches, as well as by the earlier forking of the externomedian vein, and from *E. patiens* by the very different mediastinal area. It is, on the whole, nearer the latter.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; two specimens, Nos. 2106 *a-b, c*.

17. *ETOBLATTINA OCCIDENTALIS*.

Etolblattina occidentalis Scudd., Mem. Bost. Soc. Nat. Hist., IV, 410-411, pl. 32, fig. 4 (1890); Foss. Ins. N. A., I, 386-387, pl. 24, fig. 4 (1890).

Lawrence, Kans. Dr. S. W. Williston, of the University of Kansas, tells me that the locality at which it was found, in the old fair ground near the city, is at about the middle of the true Carboniferous of Kansas, as nearly as he can make it out.

18. *ETOBLATTINA EXIGUA* sp. nov.

Pl. V, fig. 4.

Tegmina somewhat less than three times as long as broad, the inner margin straight, the costal margin strongly arcuate, but much less so in the apical half, the apex probably well rounded. Mediastinal area triangular, the vein being straight and terminating well before the distal end of the middle third of the tegmina; the branches are obscure but probably very longitudinally oblique and few in number. The scapular vein is broadly sinuate, terminating just above the extreme apex of the tegmina; it has but very few, three or four, very longitudinally oblique, feebly arcuate branches, mostly simple, their course parallel to the mediastinal vein. The externomedian vein is arcuate and has but two longitudinal branches, the first originating in the center of the tegmina and forked to its root, the other not far before the margin; probably all three of these are forked next the apical margin (broken in the only specimen). The internomedian vein is arcuate at first, straight apically, and terminates a little beyond the middle of the distal half of the tegmina; the branches are few in number and distant, the first one deeply forked, the others simple, straight, and oblique. The anal furrow is not very strongly arcuate, deeply impressed only in its basal half, and terminates a little beyond the end of the proximal third of the tegmina; the anal veins are few, distant, simple, parallel, subequidistant, and arcuate. The basal portion of the mediastinal vein is impressed as deeply as the anal furrow, while the basal portions of the externomedian and internomedian veins are borne on the summit of a ridge between them. The surface of the tegmina is blackish brown and all the nervures are bordered for fully a fourth of the distance to the neighboring nervures with black, more distinctly in the anal area than elsewhere; and there is a feeble very crowded straight cross lining between the nervules.

Length of fragment, 9.25 mm.; probable length of tegmina, 11.75 mm.; breadth, 4.2 mm.

This species is remarkable for the paucity of its neuration, and is not closely allied to any other species yet known.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2107 *a-b*.

19. ETOBLATTINA sp.

Pl. V, fig. 2.

Etoblattina sp. Scudd., Bull. U. S. Geol. Surv., No. 101, 18, pl. 2, fig. h, (1893).

From the Lower (?) Productive Coal-measures of Pawtucket, R. I.

20. ETOBLATTINA JEFFERSONIANA sp. nov.

Pl. V, fig. 7.

The only specimen of this species is a fragment from the middle half of the tegmina, with striking neuration; probably the tegmina were about two and a half times as long as broad, with both costal and inner margins gently convex, indicating a very regular oblong-obovate form. On this hypothesis, the mediastinal vein extended considerably beyond the middle of the tegmina, nearly to the distal end of the middle fifth, and was vittate, tolerably broad, with rather distant, parallel, straight, oblique branches. The scapular vein is extraordinarily distant from the mediastinal, strongly and regularly arcuate, and terminates probably short of the apical margin; it first forks just beyond the middle of the proximal half of the tegmina, and has about five inequidistant branches, which are long, arcuate, and simple or deeply, rarely doubly, forked, having the same trend as the mediastinal branches. The externomedian vein is broadly arcuate, first forks a little within the proximal two-fifths of the tegmina, and has about four longitudinal branches, the earlier ones compound and gently arcuate, the later ones simple or forked and nearly straight. The internomedian vein is broadly sinuate, the area being apically and very gradually attenuate, and probably reaching beyond the scapular area, with branches which are gently arcuate, simple, oblique, and become more and more longitudinal, about as distant as the mediastinal branches. The surface of the tegmina is uniformly carbonaceous, and there is no sign of any cross lines.

Length of fragment, 15 mm.; probable length of tegmina, 23.5 mm.; breadth, 9.5 mm.

This species bears some resemblance to the European *E. ornatissima*, but from the imperfection of the latter the scapular areas can not be compared; it seems, however, to have been in this direction wholly unlike our species. *E. jeffersoniana* also somewhat resembles our *E. gratiosa*, but differs entirely in the length and character of the mediastinal area and the peculiarities of the scapular venation.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; one specimen, Nos. 186 and 184.

21. *ETOBLATTINA RESIDUA* sp. nov.

Pl. V, fig. 1.

A portion only of one of the tegmina is preserved in the only specimen of this species seen, lacking the entire costal margin, but the greater part of the neuration is preserved and shows a peculiar species. The tegmina are apparently about two and a half times longer than broad with a nearly straight inner margin; the costal margin was probably somewhat strongly arcuate and the apex subacuminate, the tegmina tapering from before the middle. A fragment only of the mediastinal vein is preserved, showing the area to have been remarkably narrow, terminating before the distal end of the middle fifth of the tegmina. The scapular vein is rather strongly sinuate, and terminates somewhat before the apex of the tegmina; it first forks before the tip of the anal furrow, hardly beyond the basal fifth of the tegmina, and probably has five or six simple or forked, long, straight, and remarkably longitudinal branches. The externomedian vein is similarly sinuate, first forks but little beyond the scapular and has but two branches, the second emitted near the middle of the tegmina, the branches doubly forked or compound, gently arcuate and longitudinal. The internomedian vein is strongly sinuate, apically very attenuate, but fails even to reach the apical margin; it has seven or more rather distant branches, the proximal nearly straight, the distal arcuate and longitudinally oblique. The anal furrow is strongly arcuate, scarcely impressed, terminating at the end of the basal fourth of the tegmina, so that the area is remarkably abbreviated. The surface is uniformly black and the interspaces traversed by rather crowded delicate cross lines.

Length of fragment, 11 mm.; probable length of tegmina, 15.5 mm.; breadth of fragment, 5.25 mm.; probable complete breadth, 6 mm.

This species seems to be most nearly, but not closely, allied to *E. jeffersoniana*, but differs from it in form, in the narrowness of the mediastinal, scapular, and apical portion of the internomedian areas, and in the totally different formation of the scapular mode of branching.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2131a.

22. *ETOBLATTINA FUNERARIA* sp. nov.

Pl. V, fig. 5.

Tegmina oval, two and a half times as long as broad, the inner margin straight before the apex, the costal margin strongly and pretty regularly convex, the apex probably well rounded. The mediastinal area is vittate, rather narrow, almost two-thirds as long as the tegmina, with rather few, inequidistant, straight or arcuate, simple, strongly oblique branches. The scapular vein is nearly straight but feebly and

very broadly sinuate, terminating at no great distance before the apex of the tegmina; it first forks at the end of the proximal third of the tegmina, and has five or six very oblique feebly arcuate branches, which are apically forked at a distance from the margin equal to the width of the mediastinal area. The externomedian vein, at first arcuate, is thereafter nearly straight, longitudinally oblique and apically faintly arcuate; it first forks just beyond the scapular vein, and in the middle of the tegmina has three longitudinally and gently arcuate forked or doubly forked branches. The internomedian vein is arcuate, very feebly except at base, and terminates long before the apex of the tegmina with five or six rather distant, simple, arcuate, oblique or longitudinally oblique branches. The anal furrow is strongly bent arcuate, strongly impressed, and terminates somewhat beyond the end of the proximal third of the tegmina; the anal veins are simple, at first distant and arcuate, then sinuate, then proximate and straight, in passing from the anal furrow. All the nervures, but especially those of the anal area, are strongly and rather broadly edged with black, giving the whole a funereal appearance, and in the anal and internomedian areas, and to a faint degree elsewhere, are distinct cross lines closely crowded and straight between the nervules.

Length of largest fragment, 14.5 mm.; probable length of tegmina, 17.5 mm.; breadth, 7 mm.

This species is of the type of *E. russoma* of Europe, from which it differs mainly in the characteristics of the scapular vein, and the small number of externomedian veinlets. It also resembles, in many points, some of our own species, such as *E. exsecuta*, from which it may be separated by its broader and less attenuated internomedian area, which feature, as well as the relatively greater breadth of the tegmina, separates it from *E. accubita* and *E. expulsata*.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; two specimens, Nos. 2108 *a-b, c*.

23. ETOBLATTINA EXPUNCTA sp. nov.

Pl. V, fig. 6.

Tegmina a little more than two and a half times longer than broad, ovate, with gently arcuate costal border, very gently arcuate inner border and probably well-rounded apical border. Mediastinal area vittate, apically attenuate, reaching slightly beyond the distal end of the middle third of the tegmina; the branches few, simple, straight, and longitudinally oblique. Scapular and externomedian veins apparently united in the proximal fourth of the tegmina, the scapular thereafter straight and terminating at the very apex; it first forks almost immediately after its freedom from the externomedian vein and before the middle of the tegmina, and has at least three longitudinally oblique gently arcuate branches, all arising before the middle of the distal half

of the tegmina and all deeply forked, the first very deeply and doubly forked. The externomedian vein is bent at parting from the scapular and is thereafter straight and oblique, and has four or five subequidistant, straight, simple, longitudinal branches. Internomedian vein arcuate at base, beyond straight, terminating in the middle of the distal two-fifths of the tegmina, with numerous and crowded, mostly simple, straight, oblique branches. The anal furrow is concealed in the only specimen seen by the slipping forward of the partially detached anal area, but the vaulting of the latter indicates that it was deeply impressed, pretty strongly arcuate, and terminated at about the end of the proximal third of the tegmina; anal veins numerous, gently arcuate, mostly simple, but some deeply forked. The surface of the tegmina is uniformly black, apparently delicately shagreened and there is no trace of cross lines.

Length of fragment, 11 mm.; probable length of tegmina, 15 mm.; breadth, 5.75 mm.

The species is somewhat allied to *E. mucronata*, but has an altogether different mediastinal area, with no such tapering form of the tegmina. *E. debilis* has the same basal union of the scapular and externomedian veins, but that species has much broader tegmina and very different internomedian branches. *E. russoma* is its nearest European ally, but it is very different from that species at nearly every point.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2109 *a-b*.

24. ETOBLATTINA GORHAMI.

Pl. V, fig. 8.

Etolblattina gorhami Scudd., Bull. U. S. Geol. Surv., No. 101, 17-18, pl. 2, fig. *a* (1893).

From the Lower (?) Productive Coal-measures of Pawtucket, R. I.

25. ETOBLATTINA APERTA sp. nov.

Pl. V, fig. 9.

Although only the middle half of one of the tegmina of the specimen on which this species is based is preserved, it retains nearly all the most characteristic features of the tegmina and is so remarkable that it can not be passed by. To judge by the margins preserved and by the course of the veins and their branches it had a tapering oval form, the tegmina considerably less than three times as long as broad, and probably tapering from near the middle of the proximal half apexward. The mediastinal vein appears on the fragment only by its tip, which reached but little beyond the middle of the tegmina, the branches very oblique. The scapular vein ran in a tolerably straight course not far above the middle line of the tegmina to a little beyond the center, when it curved strongly upward to the costal margin, which it struck not far

from the proximal end of the distal fifth of the tegmina; it probably first forked not far beyond the proximal fourth of the tegmina and had four considerably arcuate, oblique, simple or more or less deeply forked branches. The externomedian vein is nearly straight, very distant from the scapular, and has in the fragment only a single but very important and singular branch, which, unless there is a slight branch to the main vein near the tip, takes all the divarication that appertains to the main stem, for, curving in the same sense as the main scapular vein and slightly approaching it, it throws off, subparallel to the main stem, three longitudinal and arcuate simple or forked branchlets. The internomedian vein, too, is peculiar; it lies at an extraordinary distance from the externomedian vein, and soon after its freedom from the anal area runs completely parallel to the inner margin and at no great distance from it, the area being in the middle less than a fourth of the width of the tegmina, and probably terminates on the apical margin, where it curves around to meet its straight course; the branches are simple, distant, strongly arcuate and longitudinally oblique. The main veins are heavily and broadly, the branches narrowly, margined with black, and there is very faint sign of crowded cross lining between the nervures.

Length of fragment, 9 mm.; probable length of tegmina, 16 mm.; breadth, 6 mm.

This species is most nearly allied to *E. fasciata*, but differs from it in the still narrower internomedian area and the totally different neuration of the externomedian vein. I formerly¹ regarded it as the same, but there can be little doubt of its distinctness.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2066 *a-b*.

26. ETOBLATTINA FASCIATA.

Pl. V, fig. 11.

Etolblattina fasciata Scudd., Proc. Bost. Soc. Nat. Hist., XXIV, 47-48, 1889.

The second specimen described under this name in the above-mentioned paper (p. 48) was wrongly referred to this species and is here described as *E. aperta*, No. 25. No further specimens of the present species have been found.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County.

27. ETOBLATTINA RAMOSA sp. nov.

Pl. V, fig. 12.

The greater and nearly all the important part of one of the tegmina shows them to be of a lanceolate form, but with the costal far more strongly arcuate than the inner margin, with a probably strongly

¹ Proc. Bost. Soc. Nat. Hist., XXIV, 48.

rounded somewhat pointed apex, the whole about two and a half times longer than broad. The mediastinal vein is straight and subparallel to the arcuate margin in the middle of its course, and roundly bent toward the margin at the origin of its last offshoot, ending scarcely beyond the middle of the tegmina; the branches are distant, gently arcuate, strongly oblique and apically narrowly forked. The scapular vein is nearly straight, but apically slightly arcuate, terminating a little below the apex of the tegmina; it first forks a little beyond the proximal fourth of the tegmina and has four or five branches, which are strongly or longitudinally oblique, more or less sinuous, and deeply and sometimes doubly forked. The externomedian vein is nearly straight, but apically slightly sinuous and first forks scarcely before the middle of the tegmina, and has three or four inequidistant longitudinal branches, all simple or forked only apically if at all, together occupying only the narrow apical margin. The internomedian vein, at first straight, is afterward sinuous, retreating from and then advancing toward the externomedian vein, so as to leave a widened space between these main veins, much after the fashion of *Spiloblattina*, and terminating a little below the extreme apex of the tegmina; its branches are distant, longitudinally oblique and arcuate, all or nearly all more or less deeply, often doubly, forked or ramose. The anal furrow strikes the margin at about the end of the proximal third of the tegmina. The surface is black but with long, uncolored, fusiform patches in the wider interspaces, while in the blackened portions it is delicately, feebly, and minutely reticulate, the reticulations partially giving way in the internomedian area to tremulous cross lines.

Length of fragment, 16 mm.; probable length of tegmina, 25 mm.; breadth, 10 mm.

This species certainly bears a close general resemblance to *E. hastata* from the same beds, but has a much stouter form and more strongly sinuous internomedian vein, besides larger mediastinal and anal areas; the peculiarities of the branching of each vein is, however, very similar.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston, No. 108.

28. *ETOBLATTINA WILLSIANA* sp. nov.

Pl. V, fig. 13.

Tegmina lanceolate, tapering from the basal third, more than two and one-half times longer than broad, the costal margin rather strongly and pretty regularly arcuate, the inner margin scarcely arcuate, the apex subacuminate and strongly rounded. Mediastinal area long triangular, the vein very straight and terminating scarcely beyond the middle of the tegmina, the proximal branches transversely oblique and straight, the distal oblique or very oblique and arcuate, all

simple. Scapular vein broadly sinuate by the bending of the vein at the origin of the first two branches and its apical slight arcuation, terminating well before the apex of the tegmina; it has about half a dozen very oblique branches, the first branch arising near the middle of the proximal half of the tegmina and nearly continuing the basal course of the main vein; the distal branches are simple, the others deeply forked, doubly forked, or compound. The externomedian vein is gently sinuous, terminating below the apex of the tegmina, so that its branches occupy symmetrically the narrow apex; it has three distant longitudinal branches, the lower ones simple, the first, arising well before the middle of the tegmina, simple halfway to the tip, and then nearly opposite the second branch it is narrowly arborescent; it parts so narrowly from the main stem that the vein appears to have two narrowly divergent, unequal, forking branches. The internomedian vein is strongly sinuate, though straight in the middle of its course, and terminates as near the apex as the scapular vein; its branches are rather distant, all but the apical and some of the proximal forked or doubly forked, the proximal oblique and gently arcuate, the distal longitudinally oblique and arcuate. The anal furrow can not strike the inner margin far beyond the proximal third of the tegmina, but this portion is lost in the single specimen seen. The surface is carbonaceous black, with a loss of color in elongate patches in the interspaces, and the black portions are delicately and irregularly reticulate.

Length of fragment, 22.5 mm.; probable length of tegmina, 26.75 mm.; breadth, 10.25 mm.

This species is very closely allied to *E. ramosa*, but is distinguishable from it by the straightness of the mediastinal vein, the angularity of the scapular and the earlier forking and different mode of branching of the externomedian vein. Almost similar differences separate it from the straight veined *E. funesta*. In the peculiar formation of the externomedian area it bears some resemblance to the European *E. elongata*.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston, No. 176.

29. ETOBLATTINA LESQUEREUXII.

Etolblattina lesquereuxii Scudd., Mem. Bost. Soc. Nat. Hist., III, 67-69, fig., pl. 6, figs. 2, 3 (1879); Foss. Ins. N. A., I, 87-89, fig., pl. 6, figs. 3, 4 (1890).

From the roof shales of the D seam of anthracite at Yatesville, near Pittston, Pa.

30. ETOBLATTINA MALEDICTA sp. nov.

Pl. VI, figs. 1-3.

Tegmina oblong ovate, two and one-half or more times longer than broad, the costal margin broadly arcuate, the inner margin mostly straight, the apex well rounded. Mediastinal area rather narrow, vittate, the tip acuminate, ending distinctly beyond the middle of the

tegmina; the branches moderately numerous, rarely forked, very oblique, gently arcuate. Scapular vein broadly sinuate, ending a very little before the apex, first forking somewhat beyond the proximal fourth of the tegmina, with about five inequidistant branches, which are mostly deeply forked or doubly forked, arcuate, and longitudinally oblique, the first generally arising far before the others. Externomedian vein beyond the strong basal arcuation very broadly sinuate, first forking at about the middle of the tegmina, with three simple or forked branches, all nearly longitudinal, occupying at tip the apical margin only of the tegmina. Internomedian vein broadly sinuate (it is drawn too straight in fig. 2), terminating almost or quite as near the apex as the scapular vein, its branches not very numerous, arcuate and oblique, mostly simple, but occasionally deeply forked. Anal furrow rather strongly arcuate, delicately impressed, terminating at the end of the proximal two-fifths of the tegmina; anal veins simple, next the anal furrow strongly arcuate, beyond sinuate and more crowded. Surface of the tegmina carbonaceous black, with more or less fusiform brown patches in the interspaces, the black portions marked with crowded, more or less tremulous and irregular cross lines.

Length of largest fragment, 23 mm.; probable length of tegmina, 25 to 29 mm.; breadth, 9.5 to 11 mm.

This species is closely allied to *E. variegata* and *E. stipata*, but is of a stouter form, with the main veins more curved than in the former, and with less abundantly branched scapular and externomedian veins than in the latter. One of the specimens (No. 165) differs from the others in that the first branch of the scapular vein is compound and carries a much larger share than usual of the scapular system, much as in No. 163 (fig. 2), but in a still more aggressive manner.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; seven specimens, Nos. 163, 164, 165, 170, 174, 181, 192.

31. ETOBLATTINA BENEDICTA sp. nov.

Pl. V, figs. 14, 15.

Tegmina about two and one-half times longer than broad, tapering from the end of the basal third, the costal margin very strongly arcuate, the inner margin nearly straight except at the extremities, the apex subacuminate but well rounded. Mediastinal area vittate, tapering only close to the tip, which reaches about to the distal end of the middle fifth of the tegmina; the branches rarely forked, slightly arcuate, and very oblique. The scapular vein is considerably sinuate and terminates well before the apex of the tegmina; it first forks a little beyond the basal third of the tegmina and has five or six branches, of which the first two arise close together; the branches are mostly forked

or compound, most of them considerably arcuate and very oblique indeed. The externomedian vein beyond its strong basal arcuation is nearly straight, but feebly arcuate in an opposite sense; it first forks near the middle of the tegmina and has three branches which are longitudinal, nearly straight, and in the apical fourth of the tegmina forked or compound. Internomedian vein strongly sinuate, much more strongly arcuate at base than apically, the area being apically attenuate and yet terminating far before the apex of the tegmina; the distant branches are more or less arcuate, simple or apically forked and oblique. The anal furrow is strongly arcuate, scarcely impressed, and terminates before the end of the proximal third of the tegmina; the anal veins are in no instance preserved. The surface is precisely as in *E. maledicta*.

Length of large fragments, 16 to 22 mm.; probable length of tegmina, 23.5 to 24 mm.; breadth, 9 to 10 mm.

This species is very closely allied to *E. maledicta*, and will possibly be found to be identical with it; it differs principally in the much stronger arcuation of the costal border, the briefer extension of the internomedian area, and the approximation at base of the first two branches of the scapular vein. It seems to be equally abundant with *E. maledicta*, and is with it the most common of the Richmond species. The different specimens agree remarkably in the neuration of the scapular area, the greatest difference being shown in the two selected for illustration.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; six specimens, Nos. 166 and 167, 168, 178, 179 and 191, 183 and 193, 199.

32. ETOBLATTINA FUNESTA sp. nov.

Pl. VI, fig. 4.

Tegmina nearly three times as long as broad, lanceolate, tapering apically from the middle, with broadly arcuate costal margin and feebly arcuate inner margin, the apex strongly rounded. Mediastinal area moderately broad, tapering, terminating at about the distal end of the middle fifth of the tegmina, with strongly oblique, rather distant and straight, simple or forked branches. Scapular vein exceedingly straight in more than its middle half, broadly arcuate apically, and ending just before the narrow apical margin; it first forks at about the end of the proximal fourth of the tegmina, and has half a dozen straight or sinuate, strongly oblique or longitudinally oblique branches, most of them forked, and sometimes compound. The externomedian vein beyond the base is rigidly straight, scarcely bent where first forked, and has but a couple of approximate branches, occasionally three, thrown off at the middle of the tegmina and beyond, both branches straight and longi-

tudinal, soon and almost simultaneously forked and probably again forked beyond. In contrast to these the internomedian vein is strongly sinuate (though nearly straight in its middle course), leaving a wide space between it and the externomedian vein, and terminates somewhat earlier than the scapular vein; its branches are not crowded, simple, or forked, mostly the former, gently arcuate and oblique. The anal furrow terminates short of the end of the proximal two-fifths of the tegmina. The surface of the tegmina is carbonaceous black, with large, elongate, pale patches in the larger interspaces, and there is feeble sign in a few places of delicate, not very crowded, cross lining.

Length of best fragment, 20 mm.; probable length of tegmina, 27 mm.; breadth, 9.5 mm.

The species is nearly allied to *E. tenuis*, from which it differs mainly in the later and different branching of the externomedian vein and the much more strongly sinuate course of the internomedian. It is a much slenderer species than the preceding, from which it differs in the straightness of the middle veins and in its slenderer form. There is a somewhat striking difference between two of the specimens in the straightness or sinuation of the scapular branches, and especially in the proximal.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Three specimens: Mr. S. Huston, Nos. 107 and 177, 180; United States Geological Survey, No. 2186.

33. ETOBLATTINA EXSENSA sp. nov.

Pl. VI, figs. 7, 8.

Tegmina slender and lanceolate, about two and one-half times longer than broad, to judge from the fragments preserved, which only show the central portions; the costal margin gently arcuate and the inner nearly straight. Mediastinal area vittate, tapering in its apical half, acuminate, reaching to about the distal end of the middle fifth of the tegmina, the veins very oblique, simple, and straight. Scapular vein faintly arcuate, terminating slightly before the extreme apex of the tegmina, first forking only a little before the proximal fourth of the tegmina, the first branch nearly longitudinal, and bearing most of the branchlets, which are similar to those of the mediastinal vein, but distinctly less oblique; the main vein forks again several times, the first at about the middle of the tegmina, the branches longitudinally oblique and forked (very likely compound). Externomedian vein nearly straight to about the middle of the tegmina, and then bent at the first fork, following a longitudinally oblique course toward the inner margin; it has two or more forked and, perhaps, compound branches. The internomedian vein is strongly sinuous, being straight and longitudinally oblique beyond the basal arcuation to near the middle of the tegmina, thereafter parallel or subparallel to the inner margin, and doubtless curving

down toward it apically; its distant branches have a varying obliquity and are arcuate, and, at least beyond the basal ones, mostly forked or doubly forked. The anal furrow probably terminates at about the end of the proximal third of the tegmina. The surface is black, with broader or narrower elongate brown patches in the interspaces, sometimes reducing the black to a narrow bordering to the nervures, though never closely approaching the margin of the tegmina; over the black portions can be seen a delicate, close, and tremulous cross lining.

Length of fragments, 9 to 11 mm.; probable length of tegmina, 25 to 27.5 mm.; breadth, 10.5 to 11 mm.

This species closely resembles *E. tenuis*, from which it differs principally in the great importance of the first scapular branch. It is similarly distinguished from the two preceding species.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; two specimens, Nos. 161, 196.

34. ETOBLATTINA TENUIS.

Pl. VI, fig. 6.

Etolblattina tenuis Scudd., Proc. Bost. Soc. Nat. Hist., XXIV, 46-47 (1889).

This is the only one of our species with open and widely separated neuration in the center of the tegmina which bears any very close resemblance to the single European species of that type, *E. elongata* (Gein.), from the Dyas, and it is very distinct from that.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County.

35. ETOBLATTINA HUSTONI.

Pl. VI, fig. 9.

Etolblattina hustoni Scudd., Proc. Bost. Soc. Nat. Hist., XXIV, 53 (1889).

From the same place as the last mentioned.

36. ETOBLATTINA PERSISTENS.

Etolblattina persistens Scudd., Mem. Bost. Soc. Nat. Hist., IV, 459-460, pl. 41, fig. 7; pl. 42, figs. 10,¹ 19 (1890); Foss. Ins. N. A., I, 435-436, pl. 33, fig. 7, pl. 34 figs. 10,¹ 19 (1890).

This and an imperfect fragment of another and unnamed species are the only post-Paleozoic *Etolblattinæ* known.

Trias of Fair Play, Colo.

¹ A most unfortunate error occurs in one of the plates of my paper on the "Triassic insects of Fair Play" (pl. 42 of the Memoirs of the Boston Society of Natural History, vol. 4; pl. 34 of my Fossil Insects of North America, vol. 1), caused by a rearrangement of the plate after the text was prepared without a corresponding change in the text; accordingly, the following changes should be made in the numbers attached to the figures on this plate: Fig. 9 should be numbered 13; fig. 10, 9; fig. 12, 10; fig. 13, 17; fig. 15, 12; fig. 16, 15; and fig. 17 should be numbered 16. The text and plate will then correspond.

37. *ETOBLATTINA EAKINIANA* sp. nov.

Pl. VII, fig. 1.

Tegmina subovate, less than two and one-half times longer than broad, the costal margin strongly shouldered and beyond that gently and regularly arcuate, the inner margin straight, the apex probably well rounded. Mediastinal area vittate, tapering through almost the distal half, reaching to the distal end of the middle fifth of the tegmina, the branches of the vein rather close, mostly simple, increasingly oblique. Scapular vein broadly arcuate, terminating at less than halfway from the tip of the mediastinal vein to the apex of the tegmina, with two very longitudinally oblique, simple, arcuate branches arising about opposite the end of the anal furrow. Externomedian vein gracefully and uniformly sinuate, of far more importance than the scapular, first forking before the end of the proximal fourth of the tegmina, the first branch forking near the origin of the second branch, each fork again dividing halfway to the margin; the other three branches arise near together near the middle of the tegmina, and are simple or forked, all the branches arcuate, less so from above downward, and all nearly longitudinal. Internomedian vein sinuate like the preceding, terminating but little below the apex, the simple branches not crowded as in the two previous areas, slightly arcuate, oblique, and increasingly so in the distal half of the area. Anal furrow strongly and regularly arcuate, strongly impressed, terminating at the end of the proximal third of the tegmina; anal veins arcuate, simple, not numerous. The surface of the tegmina is uniformly black, with faint traces of exceedingly close cross lining in the internomedian area.

Length of fragment, 13 mm.; probable length of tegmina, 15.25 mm.; breadth, 6.5.

The characteristics of the scapular vein easily separate this from other species in the vicinity. It is named for Mr. C. L. Eakin, of Wadestown, W. Va., who has done good service in the exploitation of the locality at Cassville, which has yielded so many remains of *Etblattina*.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2111 *a-b*.

38. *ETOBLATTINA ACCUBITA* sp. nov.

Pl. VII, fig. 2.

Tegmina nearly three times as long as broad, tapering from the middle in each direction, but more sharply toward the base than toward the apex, the costal margin being very strongly and rather regularly arcuate, the inner margin nearly straight, and the apex probably well rounded. Mediastinal area vittate, terminating at the distal end of the middle fifth of the tegmina, the vein with few mostly simple,

nearly straight, strongly oblique branches. Scapular vein feebly arcuate beyond the basal sinuation, ending well before the apex of the tegmina, with three subequidistant, deeply forked or simple, longitudinally oblique branches, the middle one arising at the middle of the tegmina. Externomedian vein gracefully and rather strongly sinuate, with four mostly simple, slightly arcuate, longitudinal branches, the first arising scarcely later than the first scapular branch. Internomedian vein similarly arcuate, terminating slightly below the apex of the tegmina, the rather numerous branches mostly simple, very oblique, and feebly arcuate, the apical ones longitudinally oblique. Anal furrow less strongly arcuate than usual, terminating but little short of the middle of the tegmina; anal area destroyed in the only specimen seen. The surface is uniformly black, and there is everywhere the feeblest possible sign of close cross lining in the interspaces.

Length of fragment, 12 mm.; probable length of tegmina, 14.75 mm.; breadth, 5.25 mm.

The species is peculiar for the basal narrowing of the tegmina and the apparent length and slenderness of the anal area. It is not distantly related to *E. mazona* and other species, but differs at almost every point.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2112a.

39. ETOBLATTINA MAZONA.

Pl. VI, fig. 5. (See also fig. 3 on p. 31.)

Etolblattina mazona Scudd., Mem. Bost. Soc. Nat. Hist., III, 181, pl. 10 (1882); Proc. Bost. Soc. Nat. Hist., XXI, 392-396 (1882); Foss. Ins. N. A., I, 233, pl. 7a (1890).

From the Lowest Productive Coal-measures at Mazon Creek, Illinois.

40. ETOBLATTINA EXPULSATA sp. nov.

Pl. VII, figs. 3, 4.

Tegmina lanceolate, nearly three times as long as broad, tapering from the middle of the proximal half, the costal margin strongly arcuate, especially basally, the inner margin straight, the apex well rounded. Mediastinal area vittate, apically very attenuate, reaching the distal end of the middle third of the tegmina, the branches of the vein rather numerous, nearly straight, simple and very oblique, the apical longitudinally oblique. Scapular vein uniformly and rather strongly sinuate, ending a little before the apex, first forking at or a little beyond the end of the proximal third of the tegmina, the branches, five or six in number, mostly simple, feebly arcuate or sinuate, longitudinally oblique. Externomedian vein sinuate, more strongly arcuate at base than at apex, first forking just beyond the first scapular fork, with three longitudinal forked or doubly forked branches. Internomedian vein strongly sinuate, the area extended nearly to the tip by its apical prolongation

through a superior subramose offshoot from a little beyond the middle of the tegmina, the other branches mostly simple, arcuate, oblique, and more distant than the branches of other veins. Anal furrow strongly bent-arcuate, strongly impressed, and terminating a little beyond the end of the proximal third of the tegmina; anal area gently vaulted, the veins simple, strongly arcuate. The surface of the tegmina is blackish-brown, and the veins are marked and sometimes narrowly edged with black, while all the interspaces are traversed by very close straight or sinuate cross lines.

Length of one fragment, 14.5 mm.; probable length of tegmina, 16 mm.; breadth, 6 mm. Length of another fragment, 16.5 mm.; probable length of tegmina, 20 mm.; breadth, 7 mm.

This species is very closely allied to the next four or five species, but is sufficiently distinct from them all in the peculiar formation of the apical part of the internomedian area. The two principal specimens referred to here (and figured) differ a little in size and in the point of origin of the first scapular branch.

From the Waynesburg coal.(Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; three specimens, Nos. 2113 *a-b*, *c-d*, *e-f*.

41. *ETOBLATTINA GRATIOSA* sp. nov.

Pl. VII, fig. 5.

Tegmina ovate, somewhat less than three times as long as broad, the costal margin strongly arcuate throughout, the inner margin straight, the apex well rounded. Mediastinal area vittate, apically very attenuate, reaching fully to the distal end of the middle third of the tegmina, the branches of the vein simple, nearly straight, exceedingly oblique. Scapular vein gracefully, pretty uniformly and rather gently sinuate, subparallel to the inner margin, ending somewhat before the apex; it first branches a little beyond the proximal fourth of the tegmina, and has about five branches which have a longitudinal sweep and are mostly simply deeply and narrowly forked. The externomedian vein is strongly arcuate at the base, feebly sinuate, nearly straight in the middle and gently arcuate apically, first branching just beyond the scapular vein, and with four longitudinal, nearly straight, mostly forked branches, the forks of varying depths. Internomedian vein feebly sinuate, apically arcuate with no sign of special extension, yet terminating nearly as far out as the scapular vein; its branches are more distant than those of the other areas, simple or deeply forked, oblique and nearly straight. Anal furrow strongly bent-arcuate, deeply impressed except apically, terminating a little beyond the proximal third of the tegmina; anal veins strongly arcuate, simple or profoundly forked. The surface of the tegmina is uniformly blackish, and the interspaces are filled with crowded, straight, delicate cross lines.

Length of fragment, 16.5 mm.; probable length of tegmina, 18.25 mm.; breadth, 6.75 mm.

This species is closely allied to *E. expulsata* and has many of its special peculiarities, such as the strongly arcuate costa and the separation of the oblique internomedian veins, as well as the general distribution of the branches; but it differs from it distinctly in the structure of the extremity of the externomedian area. It also bears a close general resemblance to *E. exsecuta*, especially in the mediastinal, scapular and anal areas, but it differs from it at almost every other point. It bears also a general resemblance to the European *E. didyma*, but differs in almost every detail.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2114 *a-b*.

42. ETOBLATTINA MACERATA sp. nov.

Pl. VII, fig. 6.

Tegmina two and three-quarters times longer than broad, ovate, tapering from the middle of the proximal half, the costal margin rather strongly arcuate, especially in the proximal half, the inner margin straight, the apex well rounded. Mediastinal area vittate, apically attenuate, reaching the distal end of the middle third of the tegmina, the vein with few and rather distant, nearly straight, very oblique branches. Scapular vein broadly sinuate, terminating a little above the apex, first forking a little beyond the proximal third of the tegmina, the branches entirely similar to those of the mediastinal area, except in their greater length. Externomedian vein strongly sinuate, with four inequidistant, longitudinal, sinuate branches, simple or deeply forked, the first arising a little beyond the first scapular fork. Internomedian vein sinuate, terminating long before the apex of the tegmina, with branches about as distant as those of the mediastinal area, the proximal ones simple, gently sinuate and oblique, the distal mostly deeply forked, arcuate, and very oblique. Anal furrow strongly arched, deeply impressed, terminating scarcely short of the end of the proximal two-fifths of the tegmina; anal veins simple, strongly arcuate, distant. Surface very dark, all the veins edged narrowly, the anal veins broadly, with black, which is traversed by closely crowded straight cross veins.

Length of tegmina, 19.5 mm.; breadth, 7 mm.

This species is very closely allied to several others; the relative sparseness and simplicity of the scapular and mediastinal branches separate it from *E. expulsata* and *E. gratiosa*, and the lesser length of the mediastinal area from *E. immolata*; in the similarly early origin of the first branch of the scapular and externomedian veins it is distinct from *E. communis*, while the same characteristic and the greater stoutness of the tegmina distinguish it from *E. obatra* and *E. secreta*; from *E. obatra* it is still further separated by its simpler neurulation.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; two specimens, Nos. 2081 *a-b, c.*?

43. ETOBLATTINA IMMOLATA sp. nov.

Pl. VII, figs. 7, 8.

Tegmina somewhat more than two and a half times longer than broad, ovate, tapering from about the middle, with rather strongly arcuate costal margin (more strongly arcuate in some than in others), nearly straight inner margin and probably a well-rounded apex. Mediastinal area vittate, tapering only at extreme apex, reaching nearly to the middle of the distal half of the tegmina, the vein with simple, rarely forked, strongly oblique, nearly straight, rather abundant branches. Scapular vein more or less strongly sinuate, terminating somewhat short of the apex of the tegmina, first forking a little before a point opposite the tip of the anal furrow, with four or five simple or deeply forked, more or less arcuate, longitudinally oblique branches. Externomedian vein rather strongly sinuate, first forking scarcely beyond the scapular vein, with about four longitudinally arcuate, simple or perhaps apically forked branches. Internomedian vein gracefully and rather gently sinuate, terminating a little short of the apex of the tegmina, with six or eight arcuate, generally simple, very oblique branches. Anal furrow strongly arcuate, deeply impressed, terminating at just about the end of the proximal two-fifths of the tegmina; anal area gently vaulted, the veins rather numerous, strongly arcuate next the anal furrow, nearly straight in the opposite region. Surface exactly as in *E. macerata*.

Length of largest fragment, 14 mm.; probable length of tegmina, 17.75 mm.; breadth, 6.5 to 7 mm.

This species is closely allied to the three preceding species, but is sufficiently distinguished from them by the greater length of the mediastinal area, in which it approaches the genus *Gerablattina*. From the two following species, to which it is also very closely allied, it differs in the nearly simultaneous origin of the first branches of the scapular and externomedian veins.

The two specimens placed here differ rather unusually at one or two points, especially the arcuation of the costal margin, the breadth of the mediastinal area, and the number of internomedian branches.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe, Nos. 2115 *a-b*, *c-d*.

44. ETOBLATTINA MACTATA sp. nov.

Pl. VII, fig. 9.

Tegmina two and three-quarters times longer than broad, ovate, the costal margin very regularly and gently arcuate, the inner margin nearly as arcuate, the apex doubtless strongly rounded. Mediastinal area vittate, tapering only beyond the middle of the tegmina, reaching almost to the middle of their distal half, the vein with moderately

numerous, mostly simple, very oblique, straight branches. Scapular vein rather strongly sinuate, terminating a very little before the extreme apex of the tegmina, first branching at the end of the proximal third of the tegmina, with four or five subequidistant, arcuate, simple or forked branches, which apically have the same direction as the distal mediastinal branches. Externomedian vein strongly arcuate, first branching considerably later than the scapular vein, with three simple or deeply forked (probably reforked apically), nearly longitudinal but arcuate branches, occupying on the margin only the narrow apex of the tegmina. Internomedian vein strongly and very gracefully arcuate, terminating as near the apex as the scapular vein, with five deeply forked or simple branches, the proximal ones nearly straight and oblique, the distal arcuate and longitudinally oblique. Anal furrow very strongly arcuate except apically, sharply incised, terminating at about the end of the proximal two-fifths of the tegmina; anal area slightly vaulted, the veins gently or (toward the furrow) strongly arcuate, simple. Surface blackish brown, all the veins marked in black and perhaps delicately edged with the same, the interspaces with closely crowded straight cross lines.

Length of fragment, 15 mm.; probable length of tegmina, 18.5 mm.; breadth, 7.25 mm.

This species is separated from those which immediately precede it, and to which it is closely allied, by the relatively wide intervals between the origin of the first scapular and externomedian branches. It is still more closely related to *E. communis*, from which the greater length of the mediastinal area clearly separates it. One can not but be struck, also, by the rather strong general resemblance this insect bears to *Gerablattina concinna* from the same beds, but besides the generic distinctions between them (which are here indeed feeble), it differs in almost every detail as well as in the form of the tegmina. Of the European species it is most nearly allied to *E. dohrnii*, but not at all closely.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2116a.

45. ETOBLATTINA COMMUNIS sp. nov.

Pl. VII, figs. 10-17.

Tegmina ovate, somewhat more than two and a half times longer than broad, the costal margin gently and pretty regularly arcuate, the inner margin faintly arcuate, the apex strongly rounded. Mediastinal area vittate, apically acuminate, reaching nearly, sometimes quite, to the distal end of the middle third of the tegmina, the vein with relatively few, mostly simple, and nearly or quite straight, very oblique branches. Scapular vein faintly broadly sinuate, terminating shortly before the very apex of the tegmina, first forking at about the end of the proximal fourth of the wing, often a little after, rarely before it, the branches

three to five in number, the first generally widely separated from the second, mostly deeply forked, rarely doubly forked, but always some of them simple, and all longitudinally oblique and arcuate. Externomedian vein broadly sometimes strongly arcuate, rarely uniform, first forking some distance later than the scapular, the branches from two to four, usually four, in number, longitudinal, more or less arcuate, some of them simple, others deeply but narrowly forked, often doubly forked or even compound. The internomedian vein is gracefully sinuate, more strongly arcuate basally than apically, and ends not far from the apex but generally farther than the scapular vein; the branches are more distant than in the other areas and most of them are simple and very oblique, the distal more oblique than the proximal, but the first and some of the last are often deeply forked, and occasionally the area is apically filled by simple oblique branchlets from a longitudinally oblique preapical branch. Anal furrow strongly arcuate, impressed, terminating at a little beyond the proximal third of the tegmina; anal area gently vaulted, the veins simple and arcuate, not crowded. Surface blackish brown, all the veins marked and narrowly margined with black and the interspaces filled with crowded straight cross lines.

Length of tegmina, 16 to 21 mm.; breadth, 6 to 8 mm.

The species is sufficiently distinguished from *E. mactata*, its nearest ally, by the briefer extent of the mediastinal area; and from the four preceding species, to which it is also closely related, by the wider separation of the points of origin of the first scapular and externomedian branches. It differs in the same feature, as also in the length of the mediastinal area, from *Gerablattina uniformis*, to which its general resemblance is very striking. It appears to be the commonest species in West Virginia, where ten specimens have been found.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe, Nos. 2187 *a-b*, *c-d*, *e*, *f*, *g*, *h*, *i*, *j*, *k-l*, *m-n*.

46. ETOBLATTINA sp.

Etblattina sp. Scudd., Mem. Bost. Soc. Nat. Hist., IV, 460, pl. 42, fig. 20 (1890);
Foss. Ins. N. A., I, 436, pl. 34, fig. 20 (1890).

Triassic of Fair Play, Colo.

47. ETOBLATTINA HASTATA sp. nov.

Pl. VIII, fig. 1.

Tegmina lanceolate, tapering from a little beyond the middle of the proximal half, almost three times as long as broad, the costal margin very gently arcuate except at base and tip, where it is more strongly curved, the inner margin scarcely arcuate, the apex probably sharply rounded. Mediastinal vein straight until past the final branch, and then bent toward the margin, which it strikes before the middle of the

tegmina, with rather distant, simple or narrowly forked, arcuate, very oblique branches. Scapular vein straight, terminating scarcely above the very apex of the tegmina, first branching before the end of the proximal fourth of the tegmina, the branches not numerous, inequidistant, longitudinally oblique, irregular and deeply forked, sometimes compound. Externomedian vein also straight, nearly parallel to the scapular throughout its course, first forking far beyond the scapular at about the end of the proximal two-fifths of the tegmina, the few branches nearly longitudinal, inequidistant, and, so far as preserved, simple. Internomedian vein irregularly sinuate, falling not far short of the apex of the tegmina, in the distal half of its course subparallel to the inner margin, the branches distant, inequidistant, mostly deeply forked or compound, some simple, arcuate and very oblique. Anal furrow terminating before the end of the proximal third of the tegmina. Surface uniformly carbonaceous, covered with a delicate tremulous reticulation.

Length of fragment, 17 mm.; probable length of tegmina, 27.25 mm.; breadth, 9.5 mm.

This species is evidently not distantly related to the apparently stouter species, *E. fasciata*, but has a very different internomedian area.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; one specimen, No. 106.

48. ETOBLATTINA MARGINATA.

Pl. VIII, fig. 2.

Etblattina marginata Scudd., Proc. Bost. Soc. Nat. Hist., XXIV, 48-50 (1889).

From the same locality and horizon as the last.

49. ETOBLATTINA GRACILENTA sp. nov.

Pl. VIII, figs. 6, 7.

Tegmina almost exactly three times as long as broad, obovate, tapering but very little from about the end of the proximal third, the costal margin very strongly arcuate at base, beyond nearly straight to the rounded tip, the inner margin similarly straight, the apex rather broadly rounded. Mediastinal area narrow, vittate, but the feebly sinuate vein constantly approaching the margin in the apical half, reaching considerably beyond the proximal half of the tegmina, the branches of the vein not numerous, mostly deeply and narrowly forked, very strongly oblique. Scapular vein sinuate, much more strongly arcuate at base than beyond, where it is subparallel to the costal margin, with a varying but considerable number of inequidistant, longitudinally oblique branches, some of them arcuate, rarely simple, generally deeply forked, doubly forked or even compound, the first arising somewhat

before the end of the proximal third of the tegmina. The externomedian vein, pretty strongly arcuate at the base, is thereafter nearly straight and subparallel to the scapular vein, but gradually parts slightly from it in the distal half of the tegmina; it first forks a little before the middle of the tegmina and has but three or four deeply and narrowly forked or compound longitudinal branches. The internomedian vein, after the basal arcuation, runs in a straight longitudinally oblique course to a little beyond the middle of the tegmina, when it curves so as to run a short distance parallel to the inner margin and then curves down to it, ending somewhat before the apex; most of its inequidistant branches are broadly and deeply forked and are increasingly oblique. Anal furrow sharply and deeply impressed, strongly arcuate and terminating slightly within the proximal two-fifths of the tegmina; the anal area is vaulted, the veins few, inequidistant, simple, those next the furrow bent-arcuate and distant, the others close and sinuate. Surface carbonaceous with feeble signs of cross lining in the interspaces.

Length of largest fragment, 28 mm.; probable length of tegmina, 28 to 29.5 mm.; breadth, 9 to 9.75 mm.

This species is easily distinguished from both *E. hastata* and *E. marginata* by the sinuation of the main veins, and from at least the former by its very different form. In its larger features the neurulation resembles that of *E. willsiana*, but it is abundantly distinct from that species in every detail.

The two specimens figured differ somewhat and particularly in the length of the internomedian area, the apical space given to the externomedian area, and the proximal branches of the scapular area, which in one are more numerous and simpler than in the other.

Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; three specimens, Nos. 114, 198, and perhaps 105.

50. ETOBLATTINA EXSECUTA sp. nov.

Pl. VIII, fig. 4.

Tegmina long oval, almost three times as long as broad, tapering only from the middle, the costal margin strongly and very uniformly arcuate, the inner margin feebly arcuate, the apex pretty well rounded. Mediastinal area vittate, rather narrow, apically acuminate, terminating just before the end of the middle third of the tegmina, the branches of the vein rather few, straight, simple, and strongly oblique. Scapular vein gracefully and regularly sinuate, ending well before the apex of the tegmina, first forking just before the proximal fourth of the tegmina, with about four arcuate branches having the same trend as the mediastinal branches, simple or deeply forked. Externomedian vein strongly sinuate, more arcuate basally than apically, first forking but little beyond the scapular, with five or six sinuate, longitudinal, simple or apically

and narrowly forked branches, or with only two or three of such branches, one of them compound. Internomedian vein sinuate like the externomedian, terminating not very far short of the apex of the tegmina, with half a dozen branches, less crowded than those of the scapular and externomedian veins, arcuate and oblique, simple or deeply forked. Anal furrow strongly bent-arcuate, sharply impressed, terminating at the end of the proximal two-fifths of the tegmina, the anal veins simple, numerous, more distant, and strongly arcuate next, more crowded and straight or sinuate away from, the furrow. Surface uniformly blackish brown, with closely crowded, straight cross lines in all the interspaces.

Length of tegmina, 18.75 mm.; breadth, 6.5 mm.

This species is very closely related to *E. communis*, from which it differs in the stronger arcuation of the costal margin, its slenderer form, and the closer approximation of the first fork of the scapular and externomedian veins. It differs similarly from *E. macerata* except in the last-mentioned point, and that the scapular and externomedian branches are more crowded. It also bears a nearly similar relation to the still slenderer *E. secreta*, but it has a shorter mediastinal area and a less elongated anal area. From *E. expulsata*, to which it is also closely allied, it differs in its slenderer form, the much less arcuate costal margin, and the earlier forking of the scapular and externomedian veins.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; three specimens, Nos. 2120 *a-b*, *c-d*, *e*, besides two others probably belonging here.

51. ETOBLATTINA ARCTA sp. nov.

Pl. VIII, fig. 5.

Tegmina exceptionally long and slender, more than three and a half times longer than broad, about equally slender at both extremities, the costal margin more arcuate at base than next apex, nearly straight in the middle, the inner margin feebly arcuate at base, nearly straight beyond to the sloping tip, the apex subacuminate, very sharply rounded. Mediastinal area vittate, broad, tapering only at extreme tip, which reaches but little beyond the middle of the tegmina, the branches of the vein distant, simple, straight, oblique. Scapular vein broadly arcuate, in most of its course parallel to the costal margin, terminating at about the middle of the distal third of the tegmina, first forking scarcely before the middle of the tegmina, its branches wholly similar to the mediastinal. Externomedian vein strongly sinuate, first forking at the end of the proximal third of the tegmina, the branches longitudinally sinuate, very few in number but mostly deeply forked or compound. Internomedian vein gently and broadly sinuate, terminating not far below the apex of the tegmina, in its apical third subparallel to the margin, its five or six branches simple or forked, exceedingly oblique or

longitudinally oblique. Anal furrow with exceptionally slight and regular arcuation, impressed very sharply and very deeply indeed, terminating before the end of the proximal two-fifths of the tegmina; anal area exceptionally slender for its length, the veins few, simple and arcuate. Surface uniformly black, with signs of very feeble and close, often oblique, cross lining in the interspaces.

Length of tegmina, 18 mm.; breadth, 5 mm.

By its elongate straight form this species is very different from every other known, and it is hardly less remarkable for the imitation of the mediastinal by the scapular vein and the late forking of the latter.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2118a.

52. ETOBLATTINA STIPATA.

Pl. VIII, fig. 3.

Etblattina stipata Scudd., Proc. Bost. Soc. Nat. Hist., XXIV, 52-53 (1889).

From the Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County.

53. ETOBLATTINA PRÆDULCIS sp. nov.

Pl. VIII, fig. 12.

Tegmina lanceolate, three times as long as broad, tapering from the end of the proximal third almost as much on the inner as on the costal side, the costal margin gently and regularly arcuate, the inner nearly as much so, the apex very sharply rounded. Mediastinal area broad, tapering in nearly the distal half, terminating somewhat before the distal end of the middle third of the tegmina, the branches very oblique, nearly straight, simple or forked. Scapular vein very faintly arcuate beyond the base, terminating a little before the very apex of the tegmina, first forking at the end of the proximal third of the tegmina, with about five simple or forked, straight and long, very oblique branches. Externomedian vein feebly oblique and nearly straight beyond the base, with three longitudinal branches very distant in origin, the first arising before the first scapular fork and in the single specimen seen simple, the second arising near the middle of the tegmina and narrowly forked, the third doubly and very deeply forked. The internomedian vein is gently sinuate, though nearly straight beyond the basal arcuation, ending well before the apex of the tegmina with half a dozen moderately close, mostly simple, feebly arcuate, strongly oblique branches. Anal furrow regularly and rather strongly arcuate, moderately impressed, terminating a little beyond the end of the proximal two-fifths of the tegmina; anal veins simple, arcuate. Surface of tegmina dark brown, at least the anal and internomedian veins feebly and rather broadly

margined with black, and all the interspaces crowded with straight cross lines.

Length of fragment, 17 mm.; probable length of tegmina, 21.5 mm.; breadth, 7 mm.

This species bears a certain but not a striking resemblance in its neurulation to the much stouter *E. mediana*, and a close relation in form and neurulation to *E. rogi*; but from this latter the different character and extent of the externomedian area, as well as the longer mediastinal at once clearly separates it. Indeed the character of the externomedian area is quite different from that of any known species. In the character of the anterior half of the tegmina it is nearly related to *E. variegata*.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2119 *a-b*.

54. ETOBLATTINA VARIEGATA.

Pl. VIII, fig. 10.

Etolblattina variegata Scudd., Proc. Bost. Soc. Nat. Hist., XXIV, 51-52 (1889).

Two additional specimens of this species have been found in the original locality by Mr. Huston.

From the Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County.

55. ETOBLATTINA HILLIANA sp. nov.

Pl. VIII, fig. 11.

Tegmina oval, almost three times as long as broad, the costal margin strongly and regularly arcuate, the apex probably well rounded. Mediastinal area vittate, the vein straight nearly to the tip, which reaches the distal end of the middle fifth of the tegmina, the veins rather numerous, simple or forked, and less oblique than common. Externomedian vein broadly sinuate, much more strongly arcuate at base than apically, terminating not far before the apex of the tegmina, first forking at the end of the proximal third of the tegmina, with four or five strongly oblique, arcuate, simple, forked or multiple-forked branches. Externomedian vein very strongly sinuate in the middle of the tegmina, where the branches are thrown off straight and oblique, first branching a very little beyond the first scapular fork, with about five rather straight, longitudinal, simple, simply forked or doubly forked branches. Internomedian vein gently arcuate beyond the base, probably ending about the middle of the distal half of the tegmina, the earlier branches crowded, straight, simple, and oblique, the later more oblique, arcuate, and deeply forked. Anal furrow probably strongly arcuate and terminating not far from the end of the proximal third of the tegmina. Surface uniform, with scarcely the least sign of any cross lining.

Besides the larger part of two tegmina there is preserved a fragment of a pronotal shield which was probably of transverse oval form, much more strongly rounded in front than behind, broadest close to the posterior margin, and probably nearly half as broad again as long; its edge appears very delicately margined.

Length of entire fragment, 30 mm.; probable length of tegmina, 27.25 mm.; breadth, 9.5 mm.

This species is named after Mr. Homer D. Hill, of Morris, Ill., at the suggestion of Mr. Lacoe. Mr. Hill has been very persevering and successful in the search for fossil insects at Mazon Creek.

It does not seem to be very nearly related to any of our American species, but perhaps bears closer resemblance to *E. mazona* than to others; it shows some relation to the European *E. russoma*.

From the Lowest Productive Coal-measures of Mazon Creek, Morris, Grundy County, Ill. Mr. R. D. Lacoe; one specimen, No. 2070 *a-b*.

56. ETOBLATTINA ANGUSTA sp. nov.

Pl. VIII, fig. 8.

Tegmina very slender, two and a quarter times longer than broad, nearly parallel-sided in the middle third, tapering slowly beyond, the apex probably well rounded, the costal margin strongly convex only at base, the inner margin probably straight. Mediastinal area vittate but tapering constantly from the middle, the apex acuminate and reaching past the distal end of the middle third of the tegmina, the nearly straight simple branches of the vein changing from oblique to very oblique distally. Scapular vein straight or arcuate to its first fork (at the end of the proximal third of the tegmina), there bent and thereafter very broadly arcuate, in the middle as well as the proximal third of the tegmina subparallel to the costal margin, terminating scarcely before the very apex of the tegmina; there are about five long, nearly straight, simple or deeply forked branches. The externo-median vein is arcuate pretty regularly throughout, first forks opposite the first scapular fork, and has three or four longitudinal, gently arcuate, simple or forked branches. The internomedian vein is similarly arcuate, the area apically regularly attenuate, terminating but a little beyond the mediastinal vein at the distal end of the middle third of the tegmina, with four distant, straight, simple, strongly oblique branches. Anal furrow sharply impressed, terminating not far from the end of the proximal third of the tegmina. Surface blackish brown, the veins all edged rather broadly and indistinctly with black, the interspaces filled with crowded, straight, uniform cross lines.

Length of fragment, 13 mm.; probable length of tegmina, 16.5 mm.; breadth, 5 mm.

In the distribution of the neuration this species reminds one of the very much broader *E. funeraria*, but it differs in detail at every point.

It also resembles *E. hilliana* in a similar way. It is remarkable for the slenderness of the internomedian area, which is indeed hardly broader than the mediastinal.

From the Waynesburg coal (Upper Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2080 *a-b*.

57. ETOBLATTINA MACILENTA sp. nov.

Pl. VIII, fig. 9.

Tegmina scarcely less than three times as long as broad, ovate, tapering from well beyond the middle, the costal margin strongly convex at base, but beyond very faintly arcuate, not more so than (if as much as) the inner margin, the apex probably strongly rounded. Mediastinal area apically acuminate, reaching nearly to the distal end of the middle third of the tegmina, the branches of the vein straight, simple, very oblique. Scapular vein gently sinuate, terminating scarcely short of the extreme apex of the tegmina, first forking at about the end of the proximal third of the tegmina, with about four longitudinally oblique branches, the first doubly forked, the others simple and nearly straight. Externomedian vein nearly straight beyond the arcuate base, first forking somewhat, though not greatly, beyond the scapular vein, with about three longitudinal simple or deeply forked branches. Internomedian vein straight beyond the basal arcuation, terminating about the middle of the distal two-fifths of the tegmina, with straight, simple or forked, oblique branches. Anal furrow terminating not far from the end of the basal third of the tegmina, pretty regularly and strongly arcuate, situated at the depth of a depression; anal veins simple or occasionally deeply forked, arcuate, crowded. Surface uniformly black, with feeble signs of rather distinct straight cross lining in the interspaces.

Length of two fragments in juxtaposition, 10 mm.; probable length of tegmina, 12.25 mm.; breadth, 4.25 mm.

This species appears to be more closely allied to *E. angusta* than to any other, but differs much from it, not only in form but in the character of the externomedian and the width of the longer internomedian area.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va., Mr. R. D. Lacoë; one specimen, No. 2121 *a-b*.

58. ETOBLATTINA EXILIS.

Pl. IX, fig. 1.

Etblattina exilis Scudd., Bull. U. S. Geol. Surv., No. 101, 17, pl. 2, fig. *e* (1893).

From the Lower (?) Productive Coal-measures of East Providence, R. I.

59. *ETOBLATTINA ROGI* sp. nov.

Pl. IX, figs. 2, 3.

Unfortunately the basal third or more is lost from both the specimens of this evidently distinct species, and the precise form and proportions are necessarily conjectural, but the main features of the neuration are preserved. The tegmina are evidently almost or quite three times as long as broad, lanceolate, with almost equally and gently arcuate costal and inner margins, the apex subacuminate but rounded. The mediastinal area is broad and tapers regularly in the distal half, ending not far from the distal end of the middle fifth of the tegmina, the branches of the vein long, simple, straight, exceedingly oblique. Scapular vein very gently arcuate, terminating only a little before the extreme apex of the tegmina, first forking near the end of the proximal third of the tegmina, the branches simple, very deeply forked, straight, and longitudinally oblique. Externomedian vein beyond the basal arcuation straight and oblique, first forking not far from the first scapular fork, with four or five straight, longitudinal, simple or forked, occasionally doubly forked, apically arcuate branches. Internomedian vein like the preceding, terminating not far from the middle of the distal half of the tegmina, the branches mostly simple, straight, exceedingly oblique. Anal furrow ending just within the end of the proximal two fifths of the tegmina. Surface blackish-brown, the veins black and narrowly edged with black, the interspaces filled with distinct, closely crowded, straight cross lines.

Length of fragments, 12 to 15 mm.; probable length of tegmina, 18 to 20.75 mm.; breadth, 6.5 to 7.25 mm.

This species shows a certain resemblance to the similarly shaped *E. prædulcis*, but has a shorter internomedian area and a very different externomedian area. In one specimen the scapular vein first forks a little before, in the other a little after, the internomedian vein.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; two specimens, Nos. 2122 *a*, *b-c*, besides two others probably belonging here.

60. *ETOBLATTINA EXPUGNATA* sp. nov.

Pl. IX, fig. 4.

Tegmina subovate, tapering from the middle, a very little less than three times as long as broad, the costal margin rather strongly and rather regularly arcuate, the inner margin nearly straight, the apex well rounded. Mediastinal area vittate, moderately broad, tapering only near tip, which reaches fully to the end of the middle third of the tegmina, the branches of the vein not very frequent, straight, simple, and oblique, the distal branches very oblique indeed. Scapular vein arcuate, terminating just short of the extreme apex of the tegmina,

the branches, four in number, arcuate, longitudinally oblique, and simple or deeply forked. Externomedian vein arcuate, more strongly basally than apically, first forking just after the scapular, with four nearly straight, simple or deeply or apically forked branches. Internomedian vein gently sinuate, terminating not long before the apex, but before the scapular vein, the branches distant, gently sinuate, mostly simple, oblique, and apically very oblique. Anal furrow regularly and strongly arcuate, very deeply and sharply impressed, especially in the basal half, terminating at about the end of the proximal two-fifths of the tegmina; anal area vaulted, prominently so at the upper base, the veins mostly simple, occasionally deeply forked, more or less arcuate. Surface uniformly black, the interspaces with crowded, straight cross lines.

Length of tegmina, 18.25 mm.; breadth, 6.5 mm.

Except in its much longer mediastinal area, this species closely resembles *E. communis*; its narrower form and less arcuate internomedian vein separate it from *E. mactata*, to which in its general neuration it is nearly allied; and it bears a great deal of resemblance to *E. secreta*, but has a shorter and broader internomedian area and different development of the mediastinal area; it differs similarly from the next species, *E. obatra*, to which it is very closely allied, but has a longer and slenderer anal area.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2085 *a-b*.

61. ETOBLATTINA OBATRA sp. nov.

Pl. IX, fig. 5.

Tegmina subovate, slightly more than three times as long as broad, broadest just before the middle, the costal margin considerably arcuate but less so in the middle half, the inner margin straight, the apex well rounded. Mediastinal area vittate, tapering in the apical third, reaching nearly to the distal end of the middle third of the tegmina, the branches of the vein mostly simple, arcuate, and excessively oblique. Scapular vein beyond the basal arcuation faintly arcuate, terminating just before the apex of the tegmina, first forking considerably within the proximal third of the tegmina, with about four deeply forked or simple, arcuate, longitudinally oblique branches. Externomedian vein beyond the probably strong basal arcuation nearly straight and oblique, first forking about opposite the end of the anal furrow, with three longitudinal or nearly longitudinal, apically forked or deeply doubly forked, nearly straight branches. Internomedian vein sinuate, being slightly arcuate at base, faintly arcuate at tip, ending not a great way before the apex of the tegmina at the edge of the apical border, the infrequent branches straight, the proximal oblique, the distal excessively oblique, and both simple or forked. Anal furrow strongly arcuate, sharply

impressed, terminating a little short of the end of the proximal two-fifths of the tegmina; anal veins arcuate and numerous. Surface uniformly black, with faint, moderately close cross lines in the interspaces.

Length of tegmina, 17 mm.; breadth, 5.25 mm.

In the general direction of the veins and extent of the areas this species shows a great resemblance to *E. exsecuta*, but the tegmina are much slenderer, the mediastinal branches far more oblique, and the externomedian neuration simpler. It bears almost a greater resemblance, both in venation and in the form of the tegmina, to *Gerablattina concinna*, but the mediastinal area is much shorter. From the preceding species, *E. expugnata*, to which it is closely allied, it differs in form, in the crowding and obliquity of the mediastinal branches, and in the more abbreviated and relatively broader anal area.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2123 *a-b*.

62. ETOBLATTINA IMPERFECTA sp. nov.

Pl. IX, fig. 8.

Tegmina ovate, three times as long as broad, tapering only on the apical third, the middle portion equal, the costal margin gently arcuate, the inner margin straight beyond the considerable arcuation of the anal area, the apex probably well rounded. Mediastinal area moderately narrow, vittate, tapering in less than the distal third, terminating but little before the middle of the distal half of the tegmina, the branches of the vein mostly deeply forked, exceedingly oblique and arcuate. Scapular vein gently and pretty uniformly sinuate, terminating just above the apex of the tegmina, first forking opposite the tip of the anal furrow, with about four gently arcuate, deeply forked or simple, longitudinally oblique branches. Externomedian vein gently sinuate, first forking opposite the scapular, and with but this single straight and deeply forked, perhaps compound, longitudinal branch. Internomedian vein arcuate, but nearly straight in the apical half, terminating but little before the very apex of the tegmina, as near it as the scapular vein; the branches are distant, the proximal simple and oblique, the distal forked or doubly forked, very oblique and gently arcuate. Anal furrow strongly arcuate, deeply impressed in basal half, and terminating at the end of the proximal two-fifths of the tegmina; anal veins few, arcuate, simple. Surface uniformly black, the interspaces with excessively faint, close, and straight cross lining.

Length of fragment, 12.5 mm.; probable length of tegmina, 16.5 mm.; breadth, 5.5 mm.

In the general features of its neuration this species agrees at all points with *E. obatra*, but the internomedian area is slightly longer, the externomedian area of much less importance, the costal margin not so convex and the anal area distinctly fuller. In the forking and greater

longitudinality of the mediastinal branches and the paucity of the externomedian neuration it is distinctly different from *E. secreta* that follows.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2124 *a-b*.

63. ETOBLATTINA SECRETA sp. nov.

Pl. IX, figs. 6, 7.

Tegmina about three times as long as broad, ovate, broadest in the middle, but sometimes not tapering for some distance beyond, with rather strongly arcuate costal margin and straight inner margin, the apex probably well rounded. Mediastinal area vittate, not very broad, apically acuminate, reaching to about the distal end of the middle third of the tegmina, the branches of the vein not numerous, very oblique, sometimes exceedingly oblique, mostly simple. Scapular vein more or less sinuate, terminating just before the very apex, first forking at about the end of the proximal end of the tegmina, with five or six arcuate, mostly simple, sometimes deeply forked, exceedingly oblique branches. Externomedian vein sinuate, much more strongly arcuate at base than apically, first forking well beyond the scapular and not far from a point opposite the tip of the anal furrow, the three or four branches nearly straight and longitudinal, simple and deeply forked or occasionally doubly forked. Internomedian vein similar to the externomedian or slightly less sinuous, ending before the apex but reaching almost as far as the scapular, the branches rather distant, the first and sometimes the last deeply forked, the others mostly simple, straight or faintly arcuate, very oblique. or apically exceedingly oblique. Anal furrow not very strongly arcuate, well impressed, terminating at about the end of the proximal two-fifths of the tegmina; anal area vaulted, especially next the basal half of the furrow, the branches relatively few and arcuate. Surface uniformly black, with rather crowded straight cross lines in the interspaces.

Length of fragment, 15 to 15.5 mm.; probable length of tegmina, 18.5 to 19 mm.; breadth, 6.25 to 6.5 mm.

This species is closely allied to *E. imperfecta*, from which it differs principally in the distance from the base at which the scapular and externomedian veins first fork, in the general character of the externomedian vein, and in the less crowded branching of the mediastinal vein. Similar differences separate it from *E. obatra*, while the slenderer mediastinal area and greater extension of the internomedian area distinguish it from *E. expugnata*. It is also nearly allied to *E. exsecuta*, but in that species the scapular and externomedian veins first fork side by side, and in the broader anal area the veins are more crowded. Its greater slenderness separates it from *E. communis*, with which it agrees almost completely in its neuration; the mediastinal area, however, is distinctly longer than in that species.

The two specimens figured differ considerably from each other in the form of the tegmina, the obliquity of the mediastinal branches, and the sinuosity of the scapular vein, but I am inclined to think they should be regarded as belonging to one species.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; four specimens, Nos. 2125 *a-b*, *c-d*, *e-f*, *g*, besides another presumably to be referred here.

64. ETOBLATTINA RELIQUA.

Pl. IX, fig. 10.

Etolblattina reliqua Scudd., Bull. U. S. Geol. Surv., No. 101, 18-19, pl. 2, fig. *g* (1893).

From the Lower (?) Productive Coal-measures of Pawtucket, R. I.

65. ETOBLATTINA INVISA sp. nov.

Pl. IX, fig. 9.

Tegmina about three times as long as broad, ovate, largest a little before the middle, but with nearly parallel sides, the costal margin and inner margin equally and very gently arcuate in the middle two-thirds, the humeral angle probably strongly rounded, the apex well rounded. Mediastinal area moderately broad, vittate, rather rapidly tapering apically and reaching beyond the distal end of the middle third of the tegmina, the vein with few, oblique, simple branches. Scapular vein beyond the basal arcuation almost rigidly straight and terminating just short of the very apex of the tegmina; it first forks at the middle of the tegmina and has about five simple branches, like those of the mediastinal area. The externomedian vein, straight in its middle course, is broadly sinuate, first forking a little before the end of the mediastinal vein, and has three arcuate, apically longitudinal, simple, distant branches. The internomedian vein is broadly sinuate and terminates at some distance before the apex, the few branches distant, a little arcuate, the first probably deeply forked, the others simple. Anal furrow very elongate, but little arcuate and not greatly impressed, terminating beyond the proximal two-fifths of the tegmina. Surface gray, the veins all marked and broadly margined with black, in which margin only are seen straight and crowded cross lines in its interspaces.

Length of fragment, 16 mm.; probable length of tegmina, 17.5 mm.; breadth, 6 mm.

This species seems to be very different from the other open-veined *Etolblattinae*, particularly in the late forking and unimportant character of the externomedian vein, carried to excess in *E. strigosa*; it has a certain general resemblance to *E. ramosa*, but has a far more simple neuration, in which hardly a branch is forked.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2126 *a-b*.

66. ETOBLATTINA OCCULTA sp. nov.

Pl. IX, fig. 13.

Tegmina nearly parallel sided, oval, about three times as long as broad, the larger part of the costal margin very gently arcuate, the inner margin nearly straight, the apex probably well rounded. Mediastinal area narrow, vittate, tapering only apically, reaching to the middle of the distal half of the tegmina, the branches of the vein tolerably numerous, gently arcuate, oblique or very oblique, almost invariably simple. Scapular vein arcuate at base, beyond the first fork (at the end of the proximal third of the tegmina) having a general straight course and ending a little way before the apex of the tegmina, the first branch arising far before the others, the others, four or five in number, subequidistant, simple or forked, arcuate and exceedingly oblique. Externomedian vein gently sinuate, first forking well beyond the scapular, the three or four branches distant, longitudinally oblique and simple or forked or perhaps compound. Internomedian vein strongly sinuate, especially basally, terminating a little way before the apex, probably as far or nearly as far as the scapular vein, the latter half of the area slender, the proximal half with very distant, oblique, arcuate, mostly simple branches. Anal furrow strongly arcuate, strongly impressed, terminating a little within the end of the proximal two-fifths of the tegmina; anal area slightly vaulted, the veins in the portion next the furrow distant and strongly arcuate, those distant from it crowded, gently and oppositely arcuate, all simple. Surface carbonaceous black with elongate gray patches between the veins, or it may be described as gray with very broad black margins to all the veins, often confluent, especially at the ends of the interspaces; the black portion is traversed by rather crowded straight cross lines.

Length of fragment, 17 mm.; probable length of tegmina, 26 mm.; breadth, 9 mm.

This species is somewhat related to *E. balteata*, but differs in its form and the particular character of each of the areas. From the next species, *E. defossa*, it differs particularly in the very different formation of the externomedian vein. The neurulation is strikingly similar to that of *Gerablattina diversinervis*, and the great length of the mediastinal vein makes it closely resemble a *Gerablattina*; it seems, however, to belong better here.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2127 *a-b*.

67. *ETOBLATTINA LATEBRICOLA* sp. nov.

Pl. IX, fig. 11.

Tegmina nearly three times as long as broad, ovate lanceolate, with unusually subacuminate apex, the costal margin gently arcuate beyond the strongly rounded humeral curve, the inner margin gently arcuate beyond the anal furrow, the anal margin gently arcuate independently. Mediastinal area vittate, moderately narrow, tapering only beyond the middle of the tegmina, reaching nearly to the middle of the distal half of the tegmina, the branches of the vein oblique or very oblique, simple or apically forked. Scapular vein very gently and broadly sinuate, terminating but little before the very apex of the tegmina, first forking a little beyond the proximal third of the tegmina, the three equidistant branches considerably arcuate, longitudinally oblique, deeply and simply or doubly forked. Externomedian vein arcuate, first forking just beyond the scapular vein, the four or five branches longitudinal and straight, simple or deeply forked or compound, both the scapular and externomedian branches being very crowded in the apical fourth of the tegmina. Internomedian vein very gently arcuate, the area apically extended slightly so as to terminate almost as near the apex as the scapular vein, the branches distant, the proximal nearly straight, simple and very oblique, the distal more oblique and mostly forked. Anal furrow not very strongly but uniformly arcuate, somewhat strongly impressed, terminating a little before the end of the proximal two-fifths of the tegmina; anal area strongly vaulted next the furrow, the veins simple and arcuate. Surface black, with straight rather crowded cross lines on either side of the main veins in the central portions of the tegmina but not crossing the interspaces.

Length of tegmina, 17.5 mm.; breadth, 6 mm.

From the Lower (?) Productive Coal-measures of East Providence, R. I. Mr. R. D. Lacoe; one specimen, No. 2091 *a-b*.

68. *ETOBLATTINA DEFOSSA* sp. nov.

Pl. IX, fig. 12.

Tegmina elongate, probably more than three times as long as broad, ovate, the costal margin gently arcuate, the inner less so, the apex probably well rounded. Mediastinal area long and moderately wide, apically acuminate, reaching nearly or quite to the middle of the distal half of the tegmina, the branches of the vein distant, mostly simple and very oblique. Scapular vein nearly straight, apically faintly arcuate, terminating a little before the apex, the first branch arising far before the others, and all, four in number, simple or deeply or doubly forked, arcuate and longitudinally oblique. Externomedian vein first forking well before the middle of the tegmina and probably not far from the first scapular forking, this first externomedian fork and the main vein

parting like a longitudinal narrow fork and each fork very deeply forked, sometimes with a secondary deep fork, all longitudinal and sometimes arcuate. Internomedian vein in the apical half of its course subparallel to the inner border and, by means of a superior supplementary, deeply forked, arcuate, superior branch, extending the area nearly to the apex of the tegmina, the other branches distant, simple, arcuate, strongly oblique. Surface black, the interspaces with crowded, irregular, tremulous cross lines, forming in places almost an irregular reticulation.

Length of fragment, 14.5 mm.; probable length of tegmina, 28.75 mm.; breadth, 8.5 mm.

This species is closely allied to the preceding, but is apparently slenderer, and differs from it in many important features, and especially in the character of the externomedian vein. In this last characteristic it more nearly resembles *E. tenuis*, but in the character of the upper part of the tegmina it is very different from it.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2128 *a-b*.

69. ETOBLATTINA RECIDIVA sp. nov.

Pl. IX, fig. 14.

Tegmina probably about three times as long as broad, lanceolate, the costal margin gently convex, the inner nearly straight, the apex subacuminate, but well rounded. Mediastinal area terminating somewhat short of the distal end of the middle third of the tegmina, the branches of the vein very oblique and simple. Scapular vein very straight, terminating but little short of the apex, the first branch arising far before the others, rather deeply forked and bent at the fork; the others like this fork straight, very oblique indeed, and simple or forked. Externomedian vein probably nearly straight throughout and longitudinally oblique, first forking probably beyond the scapular and about at the end of the proximal third of the tegmina, the four or five branches straight, longitudinal and simple or forked. Internomedian vein beyond the basal curve nearly straight, but as a whole sinuate, terminating not much beyond the middle of the distal third of the tegmina, the branches rather distant, simple, arcuate, and oblique, or very oblique. Surface black, traversed by delicate, irregular and tremulous, crowded cross lines in all the interspaces.

Length of fragment, 8 mm.; probable length of tegmina, 19.5 mm.; breadth, 6.25 mm.

This species is perhaps as nearly allied to *E. hastata* as to any other of our species, but is very different indeed from it.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2129*a*.

ETOBLATTINA sp.

Pl. X, figs. 14, 15.

A single specimen with its reverse shows an unusually complete and excellently preserved hind wing, which must be referred to this genus. The wing is subovate, subacuminate at tip, with very gently arcuate costal and inner margins. The mediastinal vein runs parallel and close to the costal margin, with a few strongly oblique branches in an apical cluster, and a subbasal branch which runs between the main vein and the margin and is lost. The scapular vein is very straight, running to scarcely below the extreme apex of the wing, first branches a little before the middle of its course, and has four simple, forked, longitudinal branches. The externomedian vein is similarly straight, a little divergent from the scapular vein, first branches a little earlier than it, and has three long, simple, almost longitudinal branches. The internomedian vein is rigidly straight, and ends slightly further out than the mediastinal vein, with five parallel, straight, mostly simple or oblique branches. The anal furrow seems to differ from the other anal veins in there being a step in the membrane at this point, the vein itself, like the other anal veins, being more delicate than the internomedian branches next it and less deeply impressed; most of it can be traced, and, except for the points mentioned, it appears quite as a branch of the internomedian, being straight, except for an apical sinuation, and parallel to the internomedian branches; the other anal veins, of which only the apical halves appear, are similar in delicacy and direction, but gradually become more crowded, as is usual in the tegmina, and slightly arcuate; the furrow ends on the inner margin, slightly beyond a point opposite the first forking of the scapular vein. Surface uniformly blackish, the interspaces, at least near the apical margin, filled with not very close, straight but irregular cross lines.

Length of fragment, 10.5 mm.; probable length of wing, 14.5 mm.; breadth, 6.5 mm.

This is the only hind wing of an *Etoblattina* known to me in which any part of the anal area is preserved.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2084 *a-b*.

ETOBLATTINA sp.

Pl. XII, fig. 2.

Etoblattina sp. Scudd., Bull. U. S. Geol. Surv. No. 101, 13-14, pl. 2, fig. c (1893).

In the paper quoted I regarded this as a fragment of a fore wing from near the middle, somewhat allied to *E. primæva*. A renewed study shows that the costal curve is a natural one and that the fragment is rather the apical portion (with part of the tip lost) of a hind wing, in

which, possibly, the tip of the internomedian vein is included. It appears to belong to *Etoblattina*, but its special relations are indeterminate.

From the Lower (?) Productive Coal-measures of East Providence, R. I.

ETOBLATTINA (?) sp.

Pl. XII, fig. 4.

Etoblattina sp. Scudd., Bull. U. S. Geol. Surv. No. 101, p. 16, pl. 2, fig. *k* (1893).

For further remarks on this hind wing see p. 29.

From the Lower (?) Productive Coal-measures of Cranston, R. I.

10. Genus *GERABLATTINA*.

Gerablattina Scudd., Mem. Bost. Soc. Nat. Hist., III, 97-98 (1879); Foss. Ins. N. A., I, 117-118 (1890).

Next to *Etoblattina*, from which this genus is but slightly differentiated, *Gerablattina* is the prevailing type of *Palæoblattariae*, at least in this country. It appears first in the Millstone Grit—a single species in the Pennsylvania coal field—and it extends to the Permian, where it culminates, but it has not been recognized, like *Etoblattina*, in the Trias. Nearly three-quarters of the twenty-one species of this country come from the Permian, and, indeed, from the single locality at Cassville, W. Va., three from the Barren Coal-measures of Ohio, and the remaining two from the Oldest Productive Coal-measures of Rhode Island. Its absence from all Western deposits is a little curious.

In Europe its standing is disputed by *Anthracoblattina*, which there assumes exceptional importance. The ten species found there enjoy nearly the same geologic range as here and the same as *Anthracoblattina*, *Hermatoblattina*, and *Etoblattina* in Europe, namely, from the Lowest Productive Coal-measures to the Permian, inclusive, culminating, apparently, in the Upper Carboniferous deposits.

Table of the species of Gerablattina.

*a*¹. All the main veins independent from or almost from the base.

*b*¹. Tegmina relatively slender, considerably more than twice as long as broad.

*c*¹. Mediastinal area very narrow, in its middle at most hardly more than one-fifth the width of the tegmina; internomedian branches relatively distant.

*d*¹. Anal area relatively long; scapular vein first branching opposite or before the extremity of the anal area.

*e*¹. First internomedian branch very oblique, thrown off far before the end of the anal area..... 1. *G. inculta*.

*e*². First internomedian branch nearly transverse, thrown off scarcely before the end of the anal area..... 2. *G. perita*.

*d*². Anal area¹ relatively short; scapular vein first branching far beyond the extremity of the anal area.

¹ This point not known in *G. apicalis*.

Table of the species of Gerablattina—Continued.

- e*¹. Scapular area reaching the extreme apex of the tegmina.. 3. *G. apicalis*.
*e*². Scapular area not reaching the extreme apex of the tegmina.
*f*¹. Scapular vein first forking far before the middle of the tegmina, less abundantly branched than the externomedian.
4. *G. diversinervis*.
*f*². Scapular vein first forking but little before the middle of the tegmina, and more abundantly branched than the externomedian.
5. *G. richmondiana*.
*c*². Mediastinal area relatively broad, in its middle at least a fourth the width of the tegmina; internomedian branches relatively close.
*d*¹. All the mediastinal branches simple, or simply forked.¹
*e*¹. Internomedian area long drawn out, extending at least as far as, generally much farther than, the mediastinal area.
*f*¹. Internomedian area reaching, or almost reaching, the extreme tip of the tegmina.
*g*¹. Internomedian area band shaped, tapering but little, the branches numerous and relatively short..... 6. *G. cassvici*.
*g*². Internomedian area triangular, tapering much, the branches few and relatively long..... 7. *G. abdicata*.
*f*². Internomedian area falling distinctly, often considerably, short of the extreme tip of the tegmina.
*g*¹. Scapular and externomedian areas about equally important, each throwing at least half a dozen veins to the margin.
*h*¹. Tegmina very slender, fully three times as long as broad.
8. *G. concinna*.
*h*². Tegmina less slender, not more than two and a half times longer than broad..... 9. *G. uniformis*.
*g*². Scapular and externomedian areas very unequally important, one or the other with at most three or four veins on the margin.
*h*¹. Anal area long, nearly reaching the middle of the tegmina; externomedian area unimportant..... 10. *G. permanenta*.
*h*². Anal area short, about one-third the length of the tegmina, scapular area unimportant..... 11. *G. permacra*.
*e*². Internomedian area rapidly tapering, barely or not reaching the middle of the distal half of the tegmina.
*f*¹. Anal area short and broad; general course of the scapular branches arcuate in a sense opposite to that of the anal furrow.
12. *G. eversa*.
*f*¹². Anal area long and narrow; general course of the scapular branches longitudinal and straight..... 13. *G. deducta*.
*d*². Very nearly all the mediastinal branches forked and some of them compound.
*e*¹. Tegmina more than 40 mm. long; internomedian and mediastinal areas of very unequal length; scapular and externomedian areas of nearly equal importance; scapular branches only very slightly arcuate..... 14. *G. scapularis*.
*e*². Tegmina less than 20 mm. long; internomedian and mediastinal areas of equal length; scapular and externomedian areas of distinctly unequal importance; scapular branches considerably arcuate.
15. *G. fraterna*.
*b*². Tegmina relatively stout, but little or not more than twice as long as broad.

¹ In *G. abdicata* only are they sometimes doubly forked at extreme tip.

Table of the species of Gerablattina—Continued.

- c*¹. Scapular area important, first forking in basal half of tegmina, with half a dozen branches on margin.
- d*¹. Main scapular vein striking the margin below the apex of the tegmina. 16. *G. radiata*.
- d*². Main scapular vein striking the margin at the apex of the tegmina.
- e*¹. Tegmina subequal in breadth, broadly rounded at apex; main externomedian and internomedian veins sinuous.
- f*¹. Mediastinal area subequal throughout, the main veins sinuous. 17. *G. lata*.
- f*². Mediastinal area narrowing throughout, the main vein straight. 18. *G. rotundata*.
- e*². Tegmina greatly tapering in distal half, the apex subacuminate; main externomedian and internomedian veins straight beyond the arcuate base. 19. *G. ovata*.
- c*². Scapular area unimportant, first branching far beyond the middle of the tegmina and with only three or four branches on margin. 20. *G. minima*.
- a*². Externomedian and internomedian veins joined with the scapular in the basal sixth of the tegmina. 21. *G. fascigera*.

1. GERABLATTINA INCULTA sp. nov.

Pl. IX, fig. 16.

A single fore wing, not very well preserved and with the apical third lost, is all that represents this species. It is long obovate in form, nearly equal in breadth, except at the extreme end, largest in the middle, and probably about two and a half times longer than broad. The mediastinal area probably extended to the middle of the distal half of the wing, and is very narrow and equal, hardly more than a fifth the breadth of the wing; the branches of the vein are five or six in number, mostly thrown off from the proximal half of the vein, simple or simply forked and exceptionally longitudinal. The scapular vein recedes slightly from the margin in passing down the tegmina, and probably terminates at the apex; it has only two or three straight, longitudinal, sometimes very deeply forked offshoots from its only superior branch, which is thrown off at about the middle of the proximal half of the tegmina. The externomedian vein is a reversed repetition of the scapular, but branches at the middle of the tegmina only. The internomedian vein is very gently arcuate, first branches about as early as the scapular vein, has only four or five gently arcuate or straight simple branches, and extends as far as the mediastinal vein. The anal furrow is impressed moderately in only its proximal half, is bent slightly in the middle and otherwise considerably arcuate, terminating at the middle of the tegmina; the anal veins, seven or eight in number, are subparallel, successively more distant and more arcuate toward the anal furrow, and most of them simple. The surface of the tegmina is black and marked with exceedingly close cross lines at right angles to the veins they connect.

Length of fragment, 11.25 mm.; probable length of tegmina, 14.6 mm.; breadth, 6.6 mm.

The single specimen is from the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe, No. 2139a.

2. *GERABLATTINA PERITA* sp. nov.

Pl. IX, fig. 17.

The tegmina, of which only the basal portion of one is preserved, are apparently of an elongate and nearly equal form, to judge from the form of the base and the general course of the branches; certainly it must have been considerably more than twice as long as broad. The mediastinal area is exceedingly narrow, riband-like, but its exact extension can not of course be told; the vein runs parallel to the margin throughout its course, and in the middle of the wing can not occupy more than a fifth the width of the tegmina; the branches are rather distantly oblique, rather strongly arcuate, and simple. The scapular vein first forks at about opposite the tip of the anal furrow, the fork diverging somewhat strongly from the main branch, and neither the main stem nor the branch forks again in the fragment, or probably before the middle of the wing. The externomedian vein is rather strongly arcuate in the basal half of the tegmina, where it is entirely simple and is somewhat widely distant from the scapular vein. The internomedian vein is similarly or a little more strongly arcuate, diverging slightly from the externomedian before it begins to branch; it begins to throw off branches opposite the first forking of the scapular, and the two forks which are preserved in the fragment are somewhat distant and obliquely transverse. The anal area is but very slightly vaulted, the furrow strongly arcuate, terminating evidently at some distance before the middle of the tegmina; the veins are arcuate in the same sense, simple, and more and more crowded away from the anal furrow. The entire surface is traversed by finely incised, closely approximate, tremulous cross lines, and all the main veins and their main branches are broadly banded with piceous, leaving between them and along the outer edge of the main mediastinal vein (independent of its nervules) narrow colorless stripes.

Length of fragment, 9.5 mm.; probable length of tegmina, 17.5 mm.; width at extremity of anal furrow, 5.25 mm.

The single specimen and its reverse from the Waynesburg coal (Lower Permian) of Cassville, W. Va., are in the collection of Mr. R. D. Lacoe, under the number 2140 a-b.

3. *GERABLATTINA APICALIS* sp. nov.

Pl. IX, fig. 18.

Only the apical half, more or less, of one of the tegmina is preserved, so that the proportions of the same can not be definitely determined, but it was apparently of nearly the same proportions as the following species. The mediastinal area is not preserved in any portion of its

course, unless it be by the veins which are seen a little before the tip of the tegmina, but whose origin is lost. This would appear to be entirely uncertain, though it would seem as if the basal one belonged to this area, which would then correspond very closely in its extent with the following species; but in that case, to judge by the course of the scapular veins, the width of the mediastinal area must have been fully as great as there, if not greater. The scapular area, however, was of extraordinary extent, the main vein running in the apical half of the tegmina parallel to and at a great distance from the front margin and terminating exactly at the apex of the tegmina, throwing off in the apical portion three simple or deeply forked branches, having each a longitudinal course, and with no such sinuous curvature as is found in the next species. The main externomedian vein in the apical half of the tegmina runs again parallel to and at a wide distance from the scapular vein, terminating on the inner margin and sending to the apical portion of the same three simple, rather distant branches, the first of which is forked just before its tip; in the apical portion of its course the externomedian vein diverges slightly from the scapular and approaches apically the internomedian vein. This latter terminates on the apical half of the outer border, apparently very much in the same way as in *G. diversinervis*, the area appearing apically to be very much narrowed and possessing only simple, very distant and oblique branches; in the apical portion of its course the vein takes on a more longitudinal direction and thus approaches more closely to the externomedian vein, leaving between the two a constantly narrowing interspace much after the fashion of *Spiloblattina*. The entire surface of the fragment is black, excepting for dashes of the dark-gray color of the stone in the interspaces.

Length of fragment, 10.5 mm.; probable length of the tegmina, 20 mm.; apparent breadth near the middle of the tegmina, 8 mm.

Richmond, Ohio, from the Lower Barren Coal-measures, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, collected by Mr. S. Huston; No. 112.

4. GERABLATTINA DIVERSINERVIS sp. nov.

Pl. IX, fig. 15.

A single specimen of the tegmina with its reverse, showing the nearly complete wing, the apical portion only wanting, represents a species having a very elegant form, apparently nearly three times as long as broad, with the inner margin straight, the costal margin rather strongly and equally convex. The mediastinal area is riband-shaped and extends to the exact tip of the fragment or probably to well beyond the middle of the apical half of the wing; the area is narrow, in its middle hardly more than a fifth the width of the tegmina, the vein with oblique and increasingly oblique, simple, scarcely arcuate branches, numerous and subequidistant. The main scapular and externomedian veins are somewhat widely distant from each other and from the veins on either side

of them in the middle of the tegmina; the scapular is gently sinuous throughout its course, begins to fork a little beyond the basal third of the tegmina, and has four at origin strongly inequidistant, closely crowded, simple or simply forked branches, apically upcurved toward the margin of the tegmina and here no more distant from each other than the mediastinal branches; the outermost carry the scapular area only half way from the mediastinal area to the apex of the tegmina. The externomedian vein beyond its basal curvature is nearly straight throughout the greater portion of its course and emits three rather distant and at their origin widely distant, straight and longitudinal branches, simple or forked. The internomedian vein is gently sinuous throughout its course, rapidly narrows beyond its base, and extends to at least as far as, probably slightly farther than, the mediastinal area, and is furnished with seven or eight widely distant, gently arcuate, obliquely transverse, apically oblique, simple branches. The anal area is scarcely vaulted, the anal furrow deeply incised, strongly arcuate, terminating hardly beyond the middle of the basal half of the tegmina; the anal veins are few, irregularly arcuate in the same sense as the anal furrow, and rather widely distant. Along the whole all the veins and branches are broadly banded, in the mediastinal area narrowly banded, with piceous, in which the membrane of the tegmina is seen to be delicately, transversely, and numerous cross veined.

Length of fragment, which is broken slightly at the base as well as at the tip, 19 mm.; probable length of the tegmina, 25 mm.; breadth, 9 mm.

This species is closely allied to *G. perita*, but markedly different from it in the narrow extent of the scapular area, which is far from reaching the extreme apex of the tegmina.

The single specimen and its reverse came from the Waynesburg coal (Lower Permian) of Cassville, W. Va., and are in the collection of Mr. R. D. Lacoë, with the number 2141 *a-b*.

5. GERABLATTINA RICHMONDIANA sp. nov.

Pl. X, fig. 1.

This species is represented by only a single specimen, rather imperfect, but showing nearly the whole of the costal margin. The tegmina are apparently about two and one half times longer than broad, with a rather strongly and regularly arcuate costal margin; the apex is lost, but was apparently much as indicated in the figure. The mediastinal area is vittate, slightly broader than in its allies, being nearly a fourth the breadth of the tegmina in the middle, and ends a little beyond the middle of the distal half of the tegmina, the vein with rather distant, nearly straight, and strongly oblique nervules. The scapular vein is broadly sinuous, first forks only a little before the middle of the tegmina, beyond which it has numerous compound branches, the low-

est of which strike the margin scarcely if at all above the extreme apex. The externomedian vein is broadly arcuate; its first visible branch arises a little beyond the middle of the tegmina, but it is here so much farther removed from the internomedian than from the scapular vein that probably an earlier branch, obscured from the imperfect preservation of the specimen, arises not far from opposite the first branch of the scapular vein; the behavior of the branches can not be seen from the imperfection of the specimen, but there is not room for the wide radiate arrangement of compound branches possessed by the scapular vein. The internomedian vein, only the proximal two-thirds of which can be traced, is broadly arcuate, and send out only a few distant, tolerably straight branches, the first of which is twice or thrice branched on the proximal side; it probably terminates about opposite the tip of the mediastinal vein. Only the merest fragment of the anal furrow can be seen, not far from the base, but it probably terminates not far from the end of the proximal third of the tegmina; none of the anal veins are preserved. There is no trace of banding or reticulation or cross lining on the surface.

Length of fragment, 20 mm.; probable length of tegmina, 25 mm.; probable breadth, 10 mm.

This species appears to be most nearly allied to *G. diversinervis*, but the tegmina are considerably stouter, with a more strongly arcuate costa, and it differs from all the preceding species, and more nearly resembles those which follow, in the greater relative width of the mediastinal area.

Lower Barren Coal-measures of Ohio, less than 100 feet above the Crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston, No. 169.

6. GERABLATTINA CASSVICI sp. nov.

Pl. X, figs. 2, 3.

This species is represented best by a nearly complete fore wing and its reverse, showing a form and proportions very similar to the preceding, the tegmina being apparently but little less than three times as long as broad, with a very strongly arcuate costal margin and a straight or nearly straight inner margin. The mediastinal area reaches well beyond the middle of the apical half of the tegmina, the main vein gradually approaching the apex during the apical half of its course, and supplied with rather numerous, strongly oblique, arcuate, and simple or forked branches. The scapular vein is very similar to that of the foregoing species, first branching well before the middle of the tegmina, and having three simple, forked, or compound branches, all of which have an upward curvature toward the costal margin, where the nervules are as closely crowded as in the mediastinal area, and the outermost of which extend the area of the scapular vein to scarcely more than half the dis-

tance from the mediastinal area to the apex of the tegmina. The externomedian vein beyond its basal curvature is nearly straight and passes with a gentle obliquity through the tegmina, subparallel to the costal margin, first forking just before the middle of the tegmina, and having in all four or five simple or simply forked, longitudinal veins, which occupy the apex of the tegmina. The internomedian vein runs in almost exact parallelism with, but at some distance from, the externomedian vein until the middle of the apical half of the tegmina, when, besides curving into a more longitudinal course, it sends from its upper margin a forked branch toward the tip of the tegmina, which it nearly reaches; the internomedian area, therefore, narrows very gradually, and has an exceedingly great extent, while the main vein has somewhat numerous, generally simple, but sometimes deeply forked, oblique, arcuate branches. The anal area is gently vaulted, the anal furrow deeply impressed, gently arcuate, and terminates but little before the middle of the tegmina; while the anal veins, similarly arcuate, are mostly simple and rather crowded, but especially so away from the anal furrow, where usually they are apically forked. In this species, too, all the veins and their branches are broadly banded with piceous, and where the veins or branches are closely approximate the banding of two or more adjoining stems may blend, and the wing is everywhere crossed in all the parts, whether piceous or otherwise, by fine, delicate, closely crowded cross lines.

Length of fragment, 21 mm.; probable length of tegmina, 25.5 mm.; breadth of same, 9 mm.

This species is closely allied to the preceding in many respects, but has a shorter, broader, and more tapering mediastinal area, much broader, more gradually tapering internomedian area, with much more crowded neuration, and which extends far nearer the apex of the tegmina.

Two specimens and their reverses have been found in the Waynesburg coal (Lower Permian) at Cassville, W. Va., and are in the collection of Mr. R. D. Lacoë, Nos. 2142 *a-b*, *c-d*.

7. GERABLATTINA ABDICATA sp. nov.

Pl. X, fig. 6.

The single specimen representing this species has lost the apical fifth of the tegmina and the anal area, but is otherwise well preserved. It is of a very regular, elongate ovate form, broadest in the middle, and somewhat less than two and one-half times as long as broad; the costal margin is very regularly and moderately convex, the inner margin very slightly convex. The mediastinal area is of normal width, and extends, decreasing in width only distally, some distance beyond the middle of the distal half of the tegmina; the vein has but five or six very longitudinally oblique and therefore long branches, simple or

apically forked, sometimes doubly forked. The scapular vein is regularly and considerably arcuate, terminates just above the apex of the tegmina, first branches a little before the middle of the tegmina, and has only three or four simple, deeply forked, longitudinal, gently arcuate branches. The externomedian vein runs subparallel to the last, through the middle of the wing, first forks at about the middle, has but two or three nearly straight and simple longitudinal branches which fall upon the apical margin. The internomedian area reaches as far out as the scapular vein, is scarcely sinuous, and has only four or five long arcuate branches, the basal apically forked, the others simple. The anal furrow is gently impressed, rather strongly and pretty regularly arcuate, and terminates at the middle of the tegmina. The surface of the tegmina is blackish and is marked rather feebly by very close incised cross lines, nearly straight, but inclined to be tremulous, at right angles to the adjoining veins.

Length of the fragment, 14 mm.; probable length of tegmina, 16.5 mm.; breadth, 6.75 mm.

This species differs from *E. cassvici*, to which it is most nearly related, in the far greater breadth of the basal part of the internomedian area and in the relative unimportance and lower level of the externomedian area.

One specimen from the Waynesburg coal (Lower Permian) of Cassville, W. Va., in the collection of Mr. R. D. Lacoë, No. 2143a.

8. GERABLATTINA CONCINNA sp. nov.

Pl. X, figs. 4, 5.

This species is represented by a single specimen and its reverse, showing overlapping wings and tegmina, of which little can be made out, excepting the nearly complete uppermost of the tegmina, and a second specimen of an incomplete fore wing. The tegmina are very slender, slightly more than three times as long as broad, with a rather strongly arcuate costal margin, causing the tegmina to be nearly equal in their basal, somewhat rapidly tapering in their apical half, the apex falling well within the middle of the tegmina, the inner margin being straight. The mediastinal area reaches to the middle of the apical half of the tegmina, is moderately broad, tapers very regularly and uniformly in its apical half, and is filled with strongly oblique, increasingly oblique, and simple or forked, rather long branches. The scapular vein first branches at or somewhat beyond the end of the basal third of the tegmina, has a nearly straight or gently sinuous course toward the apex of the tegmina after passing its basal arcuation, and has four or five, at their origin widely distant but still closely crowded, simple or deeply forked branches, which run in a nearly straight and longitudinal course to the apical fourth of the costal margin. The basal portion of the externomedian vein and its first branch, which is not forked until

shortly before the tip, run rather near to the main scapular vein, but after its first forking the externomedian vein has a straight and strongly oblique course to a point on the inner margin at some distance beyond the tip of the mediastinal area, and thereafter has three simple or deeply forked branches having a similar direction to that of the first fork. The internomedian vein is furnished with six or eight rather closely crowded, long, simple, oblique nervules. The anal area is considerably vaulted, the anal furrow deeply impressed, strongly arcuate, and terminates a little beyond the basal third of the tegmina; the anal nervules, six to eight in number, are gently arcuate in the same sense as the anal furrow, subequidistant and simple. The surface is uniformly black, gently vaulted in all the interspaces, excepting those of the internomedian and anal areas, with no banding and but very slight signs of any transverse striation.

Length of tegmina, 18.25 mm.; breadth, 5.9 mm.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va., in the collection of Mr. R. D. Lacoë, Nos. 2077 *a-b*, *c-d*.

9. GERABLATTINA UNIFORMIS sp. nov.

Pl. X, figs. 8-11.

Known by the tegmina only, which are about two and a half times longer than broad, with very gentle and uniform arcuation to the costal margin and straight inner margin, and probably a broadly rounded tip; the tip in all cases is broken. The mediastinal area is relatively broad and not very long, barely or not extending beyond the middle of the apical half of the tegmina, tapering only in its extreme portion, and filled with strongly oblique, infrequent, simple or forked, more or less arcuate branches. The scapular area must terminate just above the apex of the tegmina; first forking scarcely beyond the middle of the basal half of the same, it has four or five branches, all of which, mostly simple but occasionally deeply forked, have an upward gentle arcuation and on the costal margin are about as equally distant from each other as the mediastinal nervules. The externomedian vein is gently sinuous throughout its course, terminating beyond the middle of the apical third of the tegmina, beginning to fork nearly as soon as the scapular vein, and having in all only three simple or very deeply forked branches, all of which are nearly straight and longitudinal. The internomedian vein is exactly parallel to the externomedian, showing a gentle sinuosity throughout, and is furnished with six or seven simple or deeply forked, strongly oblique, and gently sinuous branches. The anal furrow is rather strongly arcuate, rather deeply impressed, and terminates some distance beyond the end of the basal third of the tegmina; the anal veins are simple and parallel to the anal furrow in its vicinity, where only they are preserved. The surface of the tegmina is uniformly black, approaching piceous, with very faintly perceptible, fine, closely crowded cross lines.

Length of the most perfect specimen (fragment), 13.5 mm.; probable length of tegmina, 17.5 mm.; breadth, 7 mm.

This species is nearly allied to the preceding, *G. concinna*, but is much less slender than it.

It is represented by four specimens from the Waynesburg coal (Lower Permian) of Cassville, W. Va., in the collection of Mr. R. D. Lacoë, all but one with reverses, which bear the numbers 2082 *a-b*, *c-d*, *e*, *f-g*.

10. GERABLATTINA PERMANENTA sp. nov.

Pl. X, fig. 12.

The tegmina are elongated, regularly and very gently tapering from near the base, and about two and three-quarters times as long as broad. The mediastinal vein extends to beyond the middle of the distal half of the tegmina, the rather narrow area gently narrowing, with half a dozen deeply forked or simple, longitudinally oblique branches, increasingly oblique distally. The scapular vein is at first straight, then bent at its first fork, at about the end of the proximal third of the tegmina, and, thereafter arcuate, crosses to the lower half of the tegmina and terminates a little below the apex; it has but three or four deeply forked, longitudinal, scarcely arcuate branches. The externomedian vein is very unimportant, first branching far beyond the middle of the tegmina and sending only three or four crowded nervules to the margin. The internomedian vein is nearly straight and oblique but apically arcuate, reaching at least as far as the mediastinal vein, with seven or eight equidistant, parallel, straight, simple, oblique branches, the apical ones more longitudinal and sometimes forked. The anal furrow is rather lightly impressed, slightly bent in the middle, and rather broadly arcuate, terminating just before the middle of the tegmina; the six or eight simple, subparallel, subequidistant anal veins are straight and longitudinally oblique, becoming gently arcuate as they approach the anal furrow. The surface of the tegmina is black, in places with distinct, close, incised cross lining.

The single specimen (with its reverse) shows a pair of crossed tegmina, of which only the more perfect, lacking only the extreme tip, is drawn.

Length of better fragment, 14.25 mm.; probable length of tegmina, 15.75 mm.; breadth, 5.7 mm.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë, No. 2144 *a-b*.

11. GERABLATTINA PERMACRA sp. nov.

Pl. X, fig. 13.

Tegmina elongate elliptical in form, about three times as long as broad, with very gently and regularly arcuate costal margin and the margin of the anal area a little full. Mediastinal area broadening beyond the base, the vein being broadly sinuate and terminating at

about the middle of the distal half of the tegmina; it has eight or nine simple, straight, oblique branches, more frequent in the distal than the proximal half. The scapular vein is very unimportant, although it first forks but little beyond the middle of the proximal half of the tegmina, for it further forks only just before the margin. The externomedian area is extensive; the vein first forks but little beyond the middle of the proximal half of the tegmina, and the two forks are of about equal importance; the upper, which must be regarded as the first branch, having three simple or forked inferior offshoots occupying the apex of the tegmina; the other two superior offshoots, one simple, the other deeply forked. The internomedian vein is very gently arcuate and reaches far beyond the middle of the distal half of the tegmina, and has only three or four longitudinally oblique, simple or forked branches. The anal furrow is very slightly impressed, somewhat strongly arcuate, and terminates scarcely beyond the proximal third of the tegmina; the anal veins are few in numbers, simple, equidistant, and arcuate, parallel to the anal furrow. The surface of the tegmina is blackish brown, and shows in places the feeblest possible signs of fine and close cross lining.

Length of fragment, 15.5 mm.; probable length of tegmina, 17 mm.; breadth, 5.65 mm.

A single specimen and its reverse collected by myself in the Waynesburg coal (Lower Permian) of Cassville, W. Va., shows the whole of one of the tegmina excepting the extreme base and the inner margin. No. 2187 and 2188, United States Geological Survey.

12. GERABLATTINA EVERSA sp. nov.

Pl. X, fig. 14.

The tegmina of this species are broadest at about the middle of the proximal half, and therefore taper apparently very slowly to the apex, and are presumably about two and one-half times longer than broad; but as in the only specimen known most of the margin is lost, much is conjectural in this respect. Assuming, what can not be far wrong, that our restoration of the outline is correct, the mediastinal area, which is of normal width and similar to that of the next preceding species, terminates at about the middle of the distal half of the tegmina and the vein has six or seven straight, longitudinally oblique, simple branches. The scapular vein must terminate about at the apex of the tegmina, being broadly arcuate, with only two or three longitudinal, broadly arcuate branches, the first of which, arising near the middle of the proximal half of the tegmina, is very deeply forked. The externomedian vein is nearly straight and oblique, with two or three broadly arcuate longitudinal branches, simple or forked. The internomedian vein runs in a straight, oblique course, parallel to the

last, to about the middle of the distal half of the tegmina, and has only four or five, mostly simple, arcuate, oblique branches, the area rapidly diminishing in diameter as the vein arises high up in the tegmina. The anal furrow is very strongly arcuate, rather sharply but very delicately incised, and terminates but little beyond the middle of the proximal half of the tegmina. The surface is black and shows no sign whatever of any cross lining.

Length of fragment, 11.5 mm.; probable length of tegmina, 15.4 mm.; breadth, 6.2 mm.

The single specimen shows but little more than half of one of the tegmina, with the shoulder, anal area, and a large part of the apex, with more than the distal half of both costal and inner margins, and, the under surface being exposed, is crossed by the veins of the overlying but imperfect hind wing. It comes from the Waynesburg coal (Lower Permian) of Cassville, W. Va., and is from the collection of Mr. R. D. Lacoe, where it bears the number 2145*a*.

13. GERABLATTINA DEDUCTA sp. nov.

Pl. X, fig. 15.

The tegmina, as restored, are long elliptical, of very regular outline, probably tapering as much basally as apically, and about three times as long as broad. The costal margin, beyond the extreme basal narrowing of the tegmina (which is exceptionally great), is very gently and regularly arcuate; the other margins are lost in the only specimen known. The mediastinal vein extends to the end of the fragment and certainly to far beyond the middle of the distal half of the tegmina; it has half a dozen arcuate and rather long, simple or forked branches, and is itself rather far removed from the margin. The scapular vein probably terminates exactly at the apex of the tegmina, first forks at some distance before the middle, with two main stems of about equal value, the branches being nearly longitudinal and on the margin about seven or eight in number. The externomedian vein first branches about opposite the scapular vein, and has only two or three branches, but the first branch is compound, its branchlets divergent, so that it occupies a considerable space and probably sends at least half a dozen branchlets to the margin. The internomedian vein is regularly arcuate, and terminates before the middle of the distal half of the tegmina, and has only four or five simple, equidistant, gently arcuate branches. The anal furrow is very gently impressed, roundly bent well beyond the middle, and strikes the margin at the end of the proximal third of the tegmina. The surface is dark brown and everywhere shows delicate cross lines between the veins, very closely crowded and straight.

Length of fragment, 11 mm.; probable length of tegmina, 13.7 mm.; breadth, 4.5 mm.

The single specimen lacks the anal area, the apical sixth of the tegmina and most of the inner margin for a fifth the width of the tegmina. It comes from the Waynesburg coal (Lower Permian) of Cassville, W. Va., and is in the collection of Mr. R. D. Lacoe, with the number 2146a.

14. GERABLATTINA SCAPULARIS:

Pl. X, fig. 7.

Gerablattina scapularis Scudd., Bull. U. S. Geol. Surv., No. 101, 19, pl. 2, fig. 1 (1893).

From the Lower (?) Productive Coal-measures of Pawtucket, R. I.

15. GERABLATTINA FRATERNA.

Pl. X, fig. 16.

Gerablattina fraterna Scudd., Bull. U. S. Geol. Surv., No. 101, 19-20, pl. 2, figs. d, e (1893).

From the Lower (?) Productive Coal-measures of Silver Spring, East Providence, R. I.

16. GERABLATTINA RADIATA sp. nov.

Pl. XI, fig. 1.

A single, nearly perfect fore wing, but with the tip destroyed. It is a little more than twice as long as broad, with widely radiating veins; the costal margin is strongly arcuate, especially on the proximal half, the inner margin nearly straight, and the tip probably roundly pointed. The mediastinal area extends almost to the end of the preserved portion and probably to the apical sixth of the tegmina, and the vein has few, remarkably longitudinal, mostly simple veins, though the middle ones arise from a longitudinal subbasal branch which simulates the main vein. The scapular vein is somewhat as in the genus *Archimylacris*, for it is strongly arcuate, throughout parallel with the costal margin, and terminates distinctly below the apex of the tegmina, though it apparently does not sweep upward at tip, to judge from the veins next the distal end of the specimen; it first forks at about the end of the proximal third of the tegmina, and has three or four longitudinal branches, simple, deeply forked, or compound. The externomedian vein, very strongly arcuate in the proximal third of the tegmina, is thereafter straight and has but three simple, subequidistant branches parallel to the main scapular vein, the first arising a little before the middle of the tegmina. The internomedian vein is straight beyond the proximal third of the tegmina and terminates only a little before the distal third of the same, with four straight oblique branches, the first very deeply forked, the others simple. The anal furrow is gently arcuate beyond the very strongly arcuate base and ends with the proximal third of the tegmina; the veins are few, simple, and bent arcuate. The veins are discolored with black on a blackish castaneous ground, and there is everywhere a feeble tracery of cross lines.

Length of fragment, 13.5 mm.; probable length of tegmina, 15.5 mm.; breadth, 6.75 mm.

This species is slenderer than those which here follow it, due to the tapering of the tegmina beyond the basal third, and is remarkable for the downward course of the scapular vein, which carries it below the apex of the tegmina.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2147a.

17. GERABLATTINA LATA sp. nov.

Pl. XI, fig. 2.

Represented by a single, almost perfect specimen of one of the tegmina; this is only twice as long as broad, of somewhat regular obovate form, the costal margin pretty regularly arcuate, the apex broadly rounded, the inner margin straight. The mediastinal area is tolerably broad and extends to beyond the middle of the apical third of the tegmina, tapering only in its extreme portion, where the mediastinal vein, hitherto parallel to the costal margin, curves rather strongly upward; the area is filled with simple or simply and not deeply forked, strongly oblique nervules, rather few in number but somewhat closely crowded by their obliquity. The scapular vein, first forking but little before the middle of the tegmina, is strongly sinuous, with four, at origin rather distant branches, which are arcuate and upcurved and mostly simple and closely crowded. The externomedian vein is even more strongly sinuous, with but three simple or forked branches, occupying on the apical margin from the extreme apex downward even less space than do the scapular nervules above the apex. The internomedian vein is similarly sinuous and parallel to the externomedian, and has seven generally simple, sometimes simply forked, oblique, nearly straight or gently arcuate branches, the area itself rapidly narrowing beyond the base. The anal area is very gently vaulted with a strongly impressed, arcuate, anal furrow, terminating at about the end of the basal two-fifths of the tegmina; the anal veins are few, distant, strongly arcuate, and subparallel to the anal furrow. The surface of the tegmina is uniformly piceous throughout, and well marked with pronounced but exceedingly delicate and closely crowded tremulous cross lines.

Length, 12.5 mm.; breadth, 6.25 mm.

Represented by one specimen from the Waynesburg coal (Lower Permian) of Cassville, W. Va., in the collection of Mr. R. D. Lacoe, bearing the number 2148a.

18. GERABLATTINA ROTUNDATA sp. nov.

Pl. XI, fig. 3.

This species, represented by a single specimen broken at base, closely resembles *G. lata* in general appearance, having precisely the same form except a straighter costal margin, and being of the same size. It is slightly more than twice as long as broad, with the costal margin straight in the middle half, the apex very broadly rounded, and the anal margin straight before the apical curve. The mediastinal vein is almost perfectly straight, so that the area is triangular and terminates barely before the middle of the distal half of the tegmina; the branches of the vein are rather few, mostly simple, straight and oblique. The scapular vein is gently sinuate and terminates exactly at the apex of the tegmina; it first forks just before the end of the proximal third of the tegmina, and by the middle of the tegmina has sent out three longitudinally oblique, simple, doubly forked, or compound branches, and itself forks once near the tip, so that nearly a dozen branches fall on the upper half of the rounded apical margin of the tegmina. The externomedian vein is similarly sinuate and emits three variably forked branches, farther from the base than the scapular branches, but nearly as numerous on the margin as they. Internomedian vein broadly arcuate but reaching out to the same distance as the mediastinal vein, with four or five simple, nearly straight, oblique branches, traced with exceptional fineness on the stone. Anal furrow not very deeply incised, straight beyond the arcuate basal portion, striking the margin not far before the middle of the tegmina; the anal area is obliterated. With the exception of the internomedian area, the veins are rather deeply incised and black, though not margined, and the whole of the surface of the tegmina is nearly black; there is a feeble sign or two of transverse cross lines in the apical part of the tegmina.

Length of tegmina, 10mm.; breadth, 4.9.

This species is readily distinguished from *G. lata*, its nearest ally, by the straight mediastinal vein and arcuate instead of sinuate internomedian vein.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe, No. 2149a.

19. GERABLATTINA OVATA sp. nov.

Pl. XI, fig. 4.

The only fragment preserved is broken at the base of the tegmina, but their shape can almost certainly be restored, showing them to have been of a very distinctly ovate form, about twice as long as broad, with the costal margin very regularly and rather strongly convex and the inner margin equally convex in the apical half, producing an ovate tip. The mediastinal vein is sinuous and terminates at about the

middle of the apical half of the tegmina, is rather distant from the margin, and has but four or five simple or simply forked and rather long, rather oblique branches. The scapular vein is rather strongly sinuous, terminates barely above the apex of the tegmina, begins to fork at some distance before the middle of the tegmina, and has four simple, in one case deeply forked, nearly straight but slightly sinuous, oblique branches. The externomedian vein, beyond the arcuate base, is nearly straight, begins to fork at about the middle of the tegmina, and has four simple or medially forked, straight, longitudinal branches. The internomedian vein is parallel to the externomedian, and terminates in the middle of the apical two-fifths of the tegmina, with five straight or gently arcuate, oblique, distant branches, of very unequal length, since the area rapidly narrows from base to apex. Only a little of the anal furrow can be seen, but it plainly terminates but a little way before the middle of the inner border. The surface of the tegmina is uniform in coloring and transversely cross lined, as in the preceding species.

Length of fragment, 13.5 mm.; probable length of tegmina, 14.5 mm.; width, 7 mm.

This species is closely allied to *G. lata*, but is of a distinctly different form from the tapering of the apical half of the tegmina, which is scarcely in the least perceptible in the preceding species; the veins again are more longitudinal and less arcuate, and the neuration is also more scant.

The single specimen, represented by obverse and reverse, comes from the Waynesburg coal (Lower Permian) of Cassville, W. Va., and is in the collection of Mr. R. D. Lacoë, bearing the number 2150 *a-b*.

20. GERABLATTINA MINIMA sp. nov.

Pl. XI, fig. 5.

The tegmina would be pretty regularly elliptical in form were it not for the square shoulder formed by the anal area, but, disregarding that, would taper more apically than basally. The costal margin is very regularly and considerably arcuate, but more strongly at base than at apex; the inner margin is nearly straight to the middle of the distal half of the tegmina and then is as arcuate as the costal margin, forming a bluntly subacuminate tip; the tegmina are scarcely more than twice as long as broad and exceptionally small for a Paleozoic cockroach, being indeed the smallest known in this country, except one Permian species. The mediastinal area is of excessive breadth, reaching almost to the middle line of the tegmina, at its widest expansion; the vein is rather strongly sinuate and reaches almost to the middle of the distal fourth of the tegmina; its branches are subparallel, oblique, gently arcuate, generally simple but sometimes deeply forked, and about a dozen in number. The scapular vein is insignificant and closely parallel to the mediastinal vein; it forks only just before the middle of

the distal half of the tegmina and has but two simple branches, occupying on the margin only half the narrow space lying between the end of the mediastinal area and the extreme apex of the tegmina. The externomedian vein is also sinuate in the same sense, first forks at about the middle of the tegmina, and has only three simple or forked branches, widely separated at base. The internomedian vein is compound; its principal portion is nearly straight, but at the middle of the tegmina it has a superior apically forked branch which extends its area farther out than the mediastinal area, the main stem having half a dozen rather distant, parallel, transversely oblique, nearly straight, constantly shortening branches. The anal furrow is distinctly impressed, but more by the moderate vaulting of the anal area than by its own incision, is very strongly and regularly arcuate, and strikes the margin at about the distal end of the second fifth of the tegmina; the anal veins are numerous, closely crowded, subsinuate, parallel, longitudinally oblique and mostly simple. The surface of the tegmina is black and in places, particularly in the internomedian area, there are the feeblest possible traces of excessively fine and closely crowded straight cross lines.

Length of tegmina, 9.75 mm.; breadth, 4.7 mm.

This species is most nearly allied to *G. ovata*, but the shape of the tegmina and the relative importance of the mediastinal and internomedian areas are very different.

The single specimen known, with its reverse, is completely preserved, and was obtained by myself in the Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Nos. 2183 and 2184, United States Geological Survey.

21. GERABLATTINA FASCIGERA.

Blattina fascigera Scudd., Proc. Bost. Soc. Nat. Hist., XIX, 238-239 (1878).

Gerablattina fascigera Scudd., Mem. Bost. Soc. Nat. Hist., III, 113-115, pl. 6, figs 1 2 (1879); Foss. Ins. N. A., I, 133-135, pl. 6, figs. 1, 2 (1890).

This is the oldest known Paleozoic cockroach.

From the Interconglomerate or Millstone Grit of Campbell's Ledge, near Pittston, Pa.

11. Genus ANTHRACOBLATTINA.

Anthracoblattina Scudd., Mem. Bost. Soc. Nat. Hist., III, 87-88 (1879); Foss. Ins. N. A., I, 107-108 (1890).

This is rather a characteristic European type of Blattinariae, for it there holds a second place, while of the fourteen known species only two are American. The geologic range is the same in the two countries, and though in Europe it culminates toward the close of the Carboniferous period, the culmination is in no sense striking, as it is in some genera. In our own country one of the species occurs in the

Lowest Productive Coal-measures of the Western Interior coal-basin in Missouri, the other in the Permian of West Virginia. The genus has not before been recognized in America.

Table of the species of Anthracoblattina.

Large species, the tegmina exceeding 25 mm. in length; scapular vein first forking far earlier than the externomedian..... 1. *A. americana*.
Small species, the tegmina less than 12 mm. in length; scapular and externomedian veins first forking at about the same distance from the base.... 2. *A. virginensis*.

1. ANTHRACOBLATTINA AMERICANA sp. nov.

Pl. XI, fig. 7.

The basal half or thereabouts of a large fore wing represents apparently a species of Anthracoblattina, a genus hitherto unknown in America; the form of the tegmina can, of course, not be told with certainty, but I have attempted to restore the probable outline from the curves of that portion of the costal and inner margins which is preserved and from the course of the principal veins. The tegmina are broad with a broad well-rounded shoulder and a gently arcuate costal and nearly straight inner margin; they are probably a little more than twice as long as broad, and the broadest portion is a little beyond the middle of the anal area. The mediastinal area is remarkably broad, occupying at the base of the wing fully one-half its width, narrowing at first, afterwards remaining nearly equal to a little before the middle of the wing, when it tapers somewhat rapidly, and probably terminates at the end of the middle third of the tegmina, the vein having thus a broadly sinuous course, and throwing off at regular intervals a series (four or five are visible) of long, straight, simple, oblique branches. The scapular vein runs at the extreme base as close as possible beside the externomedian vein, parts from it before the middle of the anal area, and thereafter runs at first parallel to the costal margin; it sends off its first branch before the end of the basal third of the tegmina, its second a little before the middle of the tegmina, the first forking before the origin of the second branch; more than this can not certainly be said from the imperfect nature of the fragment, but it would appear from the course of the veins beside it that it occupies on the costal margin all the portion lying between the mediastinal area and the extreme tip of the tegmina. The externomedian vein is strongly arcuate and first forks opposite the first fork of the first branch of the scapular vein, and from its course and that of the adjoining veins it apparently forks longitudinally in the apical half of the tegmina and occupies on the margin a space considerably less than that of the scapular vein. The internomedian vein runs exactly parallel to the externomedian, and apparently terminates somewhat beyond the middle of the outer half of the tegmina; in the portion which remains it

emits two compound, gently arcuate branches, each of them forking doubly before the middle of the tegmina. The anal furrow is deeply and sharply impressed, very strongly arcuate, almost bent at right angles in its proximal half, beyond nearly straight, terminating on the margin just beyond the basal third of the tegmina; the anal area is occupied by but few veins and these at considerable distance from the anal furrow; they are forked or doubly forked, and run in a longitudinally oblique direction, that nearest the anal furrow passing a little above the middle of the area and somewhat arcuate in the same sense as the anal furrow.

Length of fragment, 15.5 mm.; probable length of tegmina, 30 mm.; breadth, 14.5 mm.

The extreme width of the mediastinal area separates this at once from any of the European species of *Anthracoblattina*.

From a coal bank near Clinton, Mo., belonging to the Lowest Productive Coal-measures. Mr. R. D. Lacoë; one specimen, No. 2137a.

2. *ANTHRACOBLATTINA VIRGINIENSIS*.

Pl. XI, fig. 8.

A nearly perfect fore wing represents a second species, remarkable for the brevity of the internomedian area; the tegmina are smaller and stouter than usual in this genus, being but little more than twice as long as broad, obovate, probably with broadly rounded apex; the costal margin is scarcely arcuate except at the extremities. The mediastinal area is distinctly less than one-third the breadth of the tegmina, at first equal, but gradually approaching the margin in its distal half by the arcuation of the main vein, which reaches the border just before the middle of the distal half of the tegmina; there are about five longitudinally oblique, generally simple, nearly straight branches. The scapular vein is broadly sinuous, being at the base strongly, at the apex feebly, arcuate, terminating at the apex of the tegmina; it first forks well before the middle of the tegmina and has about four mostly deeply forked, feebly arcuate branches, which have much the direction of those of the mediastinal area. The externomedian vein forks fully as soon as the scapular vein and has more branches, the first of which is compound (the others not fully preserved). The internomedian area is exceptionally short for an *Anthracoblattina*, the main vein being rather strongly arcuate and terminating not far beyond the middle of the tegmina; it has four gently arcuate mostly simple branches. The anal furrow is strongly and very regularly arcuate, not very deeply impressed, and terminates not far from the end of the proximal third of the tegmina; the anal area is not preserved and the other parts of the immediate base are destroyed. The surface of the tegmina is finely, but not very closely, cross-lined, except in the internomedian and the basal portion of the externomedian area, where it is irregularly and not very delicately reticulate.

Length of fragment, 10.5 mm.; probable length of tegmina, 12 mm.; breadth, 5.4 mm.

This species differs from the European species, but perhaps to a less extent from the single other American species, in the brevity of the internomedian area. It is the smallest species of the genus, which contains some of the largest of Paleozoic cockroaches, but it is not much smaller than the European *A. remigii*, from Cusel.

From the Waynesburg coal (Lower Permian), of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2138 *a-b*.

12. Genus HERMATOBLATTINA.

Hermatoblattina Scudd., Mem. Bost. Soc. Nat. Hist., III, 115 (1879); Foss. Ins. N. A., I, 135 (1890).

This genus was founded upon a couple of species from the Coal-measures of Germany, and one has since been added from the Scottish coal field. It seems to be confined to the uppermost Carboniferous beds and the Permian. No American species have yet been detected.

13. Genus PROGONOBLATTINA.

Progonoblattina Scudd., Mem. Bost. Soc. Nat. Hist., III, 118-119 (1879); Foss. Ins. N. A., I, 138-139 (1890).

This genus was founded upon a couple of European species, one occurring at the very top of the Carboniferous series in Germany, the other lower down, but in the Productive Coal-measures of Switzerland. None have since been added in Europe, and until now none have been found in America, but we are here able to add a representative from this country. It comes from the Lowest Productive Coal-measures of the Eastern Interior coal field in Illinois. The American species, however, departs less widely than the European from the other Palæoblattariæ in the more normal extent of the internomedian area, which here reaches to the distal end of the middle third of the tegmina.

PROGONOBLATTINA COLUMBIANA.

Pl. XI, fig. 9.

The tegmina are of a graceful form, very elongate oval, but with the inner side for the greater part straight, broadest at the end of the proximal third, tapering gradually to a rounded, scarcely pointed apex; both tegmina are perfectly preserved, but the neuration of one is partly lost in unimportant places; the breadth is to the length about as 1:2.6. The costal margin is very regularly and considerably arcuate, the base ovately rounded and the inner margin straight for two-thirds the length of the tegmina, unaffected by the anal area. The mediastinal area is vittate, the vein extending slightly beyond the middle of the tegmina and the seven or more branches mostly simple,

but sometimes deeply forked, increasingly oblique distally. The scapular vein is strongly and pretty uniformly sinuous, terminating just above the apex of the tegmina; on one wing it begins to branch far toward the base of the tegmina as in the other species of the genus, but on the other it does not branch until about the end of the proximal third of the tegmina; yet in the former case, the right side, the vein is much less numerously branched than in the other, although at the same time more strongly sinuous, permitting by its recession from the margin space for a larger number of offshoots; but on this side, as also in the other species of *Progonoblattina*, the branches are more nearly longitudinal, by which they are reduced in number; on the left fore wing, on the contrary, they are decidedly oblique and excepting the compound basal branch are all simple. The main course of the externomedian vein is, of course, that of the preceding; it first branches not far from the middle of the tegmina, its branches slightly arcuate and nearly longitudinal, the first compound, the others simple. The internomedian vein is regularly and gently arcuate throughout, terminating at about the distal end of the middle third of the tegmina, and has five subequidistant, nearly straight, oblique branches. The anal furrow is strongly and regularly arcuate, deeply impressed, especially toward the base, and strikes the margin a little beyond the end of the proximal third of the tegmina; the half dozen anal veins are simple, arcuate, subequidistant, parallel.

The pronotal shield is also preserved, slightly distorted by pressure. It was apparently subtruncate at base, less than twice as broad as long, strongly convex in front; it appears also to have been considerably vaulted and to have had a large discal, transverse, quadratic impression, nearly twice as broad as long, and there is also trace of a fine margination around all but the base.

The impression of some of the legs, and especially of the hind pair, appears, but only enough to say that they were slender and of a normal length.

Length from front of prothorax to tip of closed tegmina, 26 mm.; of tegmina, 20.75 mm.; breadth of same, 8 mm.; of overlapping tegmina, 14.25 mm.; of prothorax, 9.75 mm.; length of hind femora, 6.5 mm.; breadth of same, 1.75 mm.; length of hind tibia, 4.5 mm.; of tarsi, 6.5 mm.

The single specimen known lies in a natural position, with all the exposed parts preserved, and occurs with its reverse in the center of a nodule from the Lowest Productive Coal-measures of Mazon Creek, Illinois. It was received for study from Mr. William Gurley.

14. Genus ORYCTOBLATTINA.

Oryctoblattina Scudd., Mem. Bost. Soc. Nat. Hist., III, 121-122 (1879); Foss. Ins. N. A., I, 141-142 (1890).

Five species of this genus are now known—three from Europe and two from North America. The European species are found in later rocks than the American, one occurring in Dyassic, the other two in Upper Carboniferous deposits. One of our two species, indeed, is found in the Barren Coal-measures of the Western Interior coal basin, in Missouri, but the other in the Lowest Productive Coal-measures of the Eastern Interior coal basin in northern Illinois. The type is a very peculiar one, and the resemblance of one of our species (the younger) to the European is very striking, although it is still very clearly distinct; it comes also from a similar horizon.

Table of the species of Oryctoblattina.

Scapular vein with its first branch running close and parallel to the mediastinal throughout.....	1. <i>O. occidua</i> .
Scapular vein before branching diverging widely from the mediastinal, only its first branch subparallel to the mediastinal.....	2. <i>O. laqueata</i> .

1. ORYCTOBLATTINA OCCIDUA.

Oryctoblattina occidua Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 37 (1885); Mem. Bost. Soc. Nat. Hist., IV, 414-415, pl. 32, fig. 3 (1890); Foss. Ins. N. A., I, 390-391, pl. 24, fig. 3 (1890).

Lowest Productive Coal-measures of Mazon Creek, Illinois.

2. ORYCTOBLATTINA LAQUEATA sp. nov.

Pl. XI, fig. 6.

Tegmina only. The tegmina are of an elongate oval form, broadest at the end of the basal third, considerably less than three times as long as broad; the costal margin is strongly arcuate, especially at base, the inner margin gently arcuate, the apex, which is broken, evidently falling about the middle line, perhaps a little below it. The mediastinal vein runs at no great distance from the margin, subparallel to it but gradually approaching it, at last somewhat abruptly, and terminates just beyond the middle of the tegmina; it has many simple, straight, slightly oblique branches, those in the basal half interrupted by a series of connecting cross veins which disturb their regularity. The scapular vein starts in close proximity to the mediastinal in the basal fourth, diverges rapidly from it and thereafter runs at a wide distance from but subparallel to it, terminating a little less than midway between the tip of the mediastinal vein and the apex of the tegmina, and in this last portion of its course, from just before the tip of the mediastinal vein, sends to the border numerous very crowded, straight, oblique, simple veins; just beyond its change of course the scapular vein throws off

a principal branch, which emits several inferior nervules at rather wide distances apart toward the apex of the tegmina; most of these branches are simple for the greater portion of their course, or they may be deeply forked, so that eight or nine nervules strike the margin; besides this, in the interspace between the main vein and its principal branch, there is thrown off from the upper side of the principal branch a short, widely diverging vein. The externomedian vein runs in a nearly straight, gently sinuate course at no great distance from the scapular vein and its lowest branch to the inner margin, at no great distance before the tip; it has but a single branch, originating opposite the first furcation of the principal mediastinal branch, but at its origin obscured by the reticulation of the tegmina and distinct only beyond the middle of the wing, at which it divides into two distally branching veins. The internomedian vein forks close to the base, its lower branch simple, straight, and running in close proximity to the anal furrow, its upper branch forking widely opposite the tip of the former; the space upon the margin between its forks as well as between these and the lower branch is filled with numerous oblique, straight, closely crowded branches similar to the upper branches of the main scapular stem. The anal furrow is sharply but not deeply impressed, gently arcuate at the base, beyond nearly straight; of the anal veins only a pair can be seen, parallel to the anal furrow and not closely crowded. The whole surface is covered with a minute but sharp reticulation of cross veins forming cells which are generally polygonal, but, by reason of the direct or nearly direct transversality of the cross veins, mostly quadrilateral in the scapular and anal areas and between the scapular and mediastinal veins, except in the interspaces between the straight, closely crowded, marginal branches of both the costal and inner borders, which are free.

This species is remarkably similar to and yet very distinct from *O. reticulata* of the German coal, and is another remarkable instance of the similarity of many forms in the European and American Coal-measures. The general resemblance is most striking, due to the sharp and minute reticulation of the tegmina, the multiplicity of the short branches which crowd the margin in certain spots, and the general form and relative importance of the scapular vein, with its branches almost wholly dependent on not the main vein but its principal branch. It differs in the very different form of the tegmina, the lack of an independent curve to the anal area, and in the wide basal branching of the internomedian vein. As will be seen, *O. laqueata* bears a much stronger resemblance to the European species than to *O. occidua*, the only American species hitherto known.

Length of fragment, extreme tip and base being lost, 17.5 mm.; probable length of wing, 21 mm.; breadth, 7.5 mm.

The single specimen, from the Coal-measures of Kansas City, Mo., was collected by Mr. Sidney J. Hare about 170 feet above the base

of the Upper Barren Coal-measures, and is in the collection of Mr. R. D. Lacoë, under the number 2136a.

15. Genus POROBLATTINA.

Poroblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 38-39 (1885).

First described from the Triassic rocks of Colorado, where three species occur; it has now been found, not only in the Permian of West Virginia, where three more species are found, but even in the Barren Coal-measures of eastern Ohio, in which two other species are recognized, or eight species in all. It thus ranges from the Barren Coal-measures to the Trias, and, as far as yet appears, is an exclusively American type.

Table of the species of Poroblattina.

- a¹. Mediastinal area extending well beyond the middle of the tegmina; externomedian vein first forked beyond the extremity of the anal furrow.
- b¹. Externomedian vein simple, or, if forked, divided only at extreme tip. 1. *P. longinqua*.
- b². Externomedian vein more or less and deeply forked.
- c¹. Scapular vein terminating at or above the tip of the tegmina; internomedian vein and branches oblique and nearly straight.
- d¹. Mediastinal area narrowing only near extremity, which reaches far beyond the middle of the distal half of the tegmina; scapular vein sinuous, its branches almost longitudinal 2. *P. gratiosa*.
- d². Mediastinal area narrowing throughout distal half and reaching only to middle of distal half of tegmina; scapular area arcuate, its branches distinctly oblique 3. *P. fossa*.
- c². Scapular vein terminating below the tip of the tegmina; internomedian vein and branches strongly arcuate 4. *P. meieri*.
- a². Mediastinal area terminating distinctly short of the middle of the tegmina; externomedian vein first forked opposite the extremity of the anal furrow.
- b¹. Scapular vein strongly sinuous, the proximal series of branches simple. 5. *P. arcuata*.
- b². Scapular vein gently sinuous, the proximal series of branches deeply forked.
- c¹. Externomedian vein with few, distant, and simple branches.
- d¹. Internomedian vein long, with numerous but distant branches. 6. *P. lakesii*.
- d². Internomedian vein short, with very few branches 7. *P. ohioensis*.
- c². Externomedian vein with numerous, crowded, and often forked branches. 8. *P. complexinervis*.

1. POROBLATTINA LONGINQUA.

Pl. XI, fig. 12.

Although the single specimen at hand is very fragmentary and scarcely shows a natural border at any point, the portion preserved shows the larger part of the neurulation and its most essential features, which are somewhat strikingly different from those of any other species. Apparently the tegmina were of a slender ovate form, about two and a half times longer than broad, though this is conjectural. The medias-

tinal area is vittate and rather narrow, the vein with rather distant gently arcuate simple branches, and evidently ends well beyond the middle of the tegmina. The scapular vein is gently and very broadly sinuous, and retreats so from the costal margin as probably to terminate at some considerable distance below the apex of the tegmina, which is one of its striking peculiarities; it first forks a little before a point opposite the extremity of the anal furrow, and in the fragment has but two branches, both of which are or must be forked if not compound, and probably a third branch arises at a long distance from the second; all these branches are very longitudinally oblique. The externomedian vein is simple as far as it can be traced, which is through at least three-fourths of its course; it runs in a sinuous course, midway between and distant from the adjacent veins. The internomedian vein is similarly sinuous, and in the preserved portion has three (probably there are in all four or five) nearly straight and oblique distant branches. The anal furrow is feebly incised, arcuate, and scarcely bent in the middle, and terminates probably well beyond the middle third of the tegmina; anal veins not preserved. The internomedian veins are very delicate, the others rather coarse, and all are broadly bordered on each side with carbonaceous black, which in the internomedian area shows traces of delicate cross lines.

Length of fragment, 15 mm.; probable length of tegmina, 22 mm.; breadth, 8.5 mm.

In the simple or only apically forked externomedian vein and the downward embrasive sweep of the scapular vein, including the whole apex of the tegmina, this species differs strikingly from all its allies.

From the Lower Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; one specimen, No. 111.

2. POROBLATTINA GRATIOSA.

Pl. XI, fig. 13.

The tegmina, in the single instance known nearly complete, hardly taper apically, but are slender, being fully two and one-half times longer than broad, the costal margin rather gently arcuate, the inner margin straight, the apex probably well rounded. The mediastinal area is vittate and tolerably broad, extending to not very far short of the apex of the tegmina; the vein has seven or eight similar, simple, strongly oblique, nearly straight branches. The scapular vein is somewhat sinuate and terminates at the very apex of the tegmina; it branches early, well before the tip of the anal furrow and within the proximal fourth of the tegmina; in all there are about five feebly arcuate, longitudinal, mostly simple branches, arising at somewhat unequal distances apart. The externomedian vein is very feebly sinuous, longitudinally oblique, with three straight, simple or forked, very longitudinally oblique branches

arising at very unequal distances apart, the earliest a little beyond the tip of the anal furrow. The internomedian vein is very broadly arcuate (too straight in the figure) and ends before the middle of the distal half of the tegmina, and has but three nearly straight, oblique, simple or simply forked branches. The anal furrow is lightly impressed, rather regularly and rather strongly arcuate, ending on the margin not a great way beyond the proximal fourth of the tegmina; anal area lost. The entire surface is uniformly carbonaceous black and marked with exceedingly delicate, closely crowded cross lines.

Length of fragment, 11 mm.; probable length of tegmina, 13.5 mm.; breadth, 5 mm.

The great length of the mediastinal area and the infrequent branching of the scapular and externomedian veins distinguish this species from *P. fossa*, its nearest ally. Its most striking peculiarity is the behavior of the externomedian vein.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; one specimen, No. 2134 a-b.

3. POROBLATTINA FOSSA.

Pl. XI, fig. 15.

Tegmina oblong ovate in form, much more than two and one-half times longer than broad, with regularly and considerably arcuate costal margin and nearly straight inner margin. The mediastinal vein is nearly straight, with a very gentle arcuation beyond the base, and reaches nearly to the distal end of the middle third of the tegmina; its branches are straight, simple, and very longitudinally oblique. Beyond the base the scapular vein is gently and broadly arcuate, striking the apex of the tegmina; it first branches within the proximal third of the tegmina, the branch doubly forked, and thereafter, about the middle of the tegmina, has three more simple or forked branches, all parallel to those of the mediastinal area. Beyond the base the externomedian vein is straight and oblique, with three or four forked or doubly forked longitudinal branches, the first thrown off at some distance beyond the origin of the first scapular branch. The internomedian vein, beyond its gently arcuate base, is straight, parallel to the internomedian vein, and strikes the margin at the distal end of the middle fifth of the tegmina; it has four or five straight, oblique, simple branches, the first sometimes forked. The anal furrow is regularly and considerably arcuate, but little impressed, and strikes the margin at about the end of the proximal third of the tegmina; anal area not preserved. The internomedian veins are lightly impressed and delicate, the others rather deeply and coarsely; the surface is uniformly blackish, and there is no trace of marking or other sculpture.

Length of better fragment, 14 mm.; probable length of tegmina, 16.5 mm.; breadth, 6 mm.

This species is most nearly allied to the preceding, from which it differs in the form and length of the mediastinal area, the more oblique and numerous scapular veins, the more strongly convex costal margin, and probably in the form of the apex of the tegmina.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoë; two specimens, Nos. 2083 *a-b, c*.

4. POROBLATTINA MEIERI.

Petrablattina meieri Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 38 (1885); Mem. Bost. Soc. Nat. Hist., IV, 465, pl. 42, fig. 17¹ (1890); Foss. Ins. N. A., I, 441, pl. 34, fig. 17¹ (1890).

This species was wrongly referred by me to *Petrablattina*.
Triassic of Fair Play, Colo.

5. POROBLATTINA ARCUATA.

Poroblattina arcuata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 39 (1885); Mem. Bost. Soc. Nat. Hist., IV, 466, pl. 41, fig. 5 (1890); Foss. Ins. N. A., I, 442, pl. 33, fig. 5 (1890).

Triassic of Fair Play, Colo.

6. POROBLATTINA LAKESII.

Poroblattina lakesii Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 39 (1885); Mem. Bost. Soc. Nat. Hist., IV, 466, pl. 41, fig. 11 (1890); Foss. Ins. N. A., I, 442, pl. 33, fig. 11 (1890).

Triassic of Fair Play, Colo.

7. POROBLATTINA OHIOENSIS.

Pl. XI, fig. 11.

The apical third or more of the only specimen known is unfortunately lost, but the tegmina are very slender and must have been more than three times as long as broad; the costal margin is very slightly arcuate beyond the base and the inner margin straight, so that the tegmina taper very slightly and probably had a well-rounded apex. The mediastinal area is very brief and narrow and the main vein very slightly arcuate, ending but a little beyond the proximal third of the tegmina, with three or four longitudinally oblique, simple, and straight branches. The scapular is far the most important of the veins, with a sinuous course through the middle of the tegmina, terminating at the apex; it sends out a large number of branches, not very crowded, either simple or deeply forked, occasionally doubly forked, the first of which is emitted far toward the base of the tegmina or about opposite the middle of the anal area; the branches are more or less arcuate and oblique. The externomedian vein is broadly sinuous and oblique, and

¹ Erroneously marked 13 on plate. See note on p. 87.

in the part preserved shows but two branches, which are simple, but in all probability they fork in the apical portion, as there is abundant room for it. The internomedian vein runs parallel to the externomedian and strikes the inner margin not far from the middle of the tegmina; it is badly preserved and remarkably insignificant, but probably has one or two short oblique branches. The anal furrow is deeply impressed at base, but beyond only delicately incised, pretty regularly and not very strongly arcuate, and strikes the inner margin beyond the proximal third of the tegmina; the anal veins that can be seen in the portion most removed from the furrow are arcuate in a sense the reverse of that of the furrow, closely crowded, and most of them deeply forked. The scapular veins are as deeply incised as the anal furrow; the others are more delicate; the whole surface is black, and there is no sign of cross lining.

Length of fragment, 7.5 mm.; probable length of tegmina, 11 mm.; breadth at tip of anal furrow, 3.5 mm.

The tegmina are peculiar for the insignificance of the internomedian area and the contrast between the two lateral halves, as to the number and prominence of the nervules. It bears no special resemblance to any of the others.

From the Barren Coal-measures of Ohio, less than 100 feet above the crinoidal limestone, in the valley of Wills Creek, Richmond, Jefferson County. Mr. S. Huston; one specimen, No. 162.

8. POROBLATTINA COMPLEXINERVIS.

Pl. XI, fig. 14.

The last species of *Poroblattina* is represented by a single specimen of one of the tegmina, perfect in every part excepting insignificant fractures from the base and tip. The tegmina are of a very graceful subovate form, with well rounded outlines, nearly two and three-quarters times as long as broad; the costal margin is considerably and very regularly convex, the inner margin straight except at base and tip, the apex well rounded and subacuminate; the tegmina are crowded with nervures. The mediastinal area is short and narrow, terminating at the distal end of the second fifth of the tegmina, the vein with four or five oblique simple branches. The scapular vein is broadly and gently sinuous, terminating a little above the apex, with six or seven tolerably straight, oblique, generally forked branches, arising subequidistantly, the earliest about opposite the middle of the anal area. The externomedian vein is very peculiar; simple and arcuate until beyond the tip of the anal area, it appears here to throw off numerous branches on each side as it runs toward a point as far below the apex as the tip of the scapular vein is above it; but in reality it runs parallel to the internomedian vein (as in the other species of the genus), while one of its middle branches is complexly compound, spreading fan-shaped with numerous offshoots filling the lower apical portion of the tegmina, the

other branches before and after it being usually simply forked. The internomedian vein is broadly arcuate, though nearly straight in its middle half, and terminates somewhat beyond the middle of the tegmina; it has a number of feebly sinuous, straight and oblique, crowded branches. The anal furrow is deeply impressed, at least at base, and strongly arcuate, terminating on the inner margin scarcely beyond the proximal third of the tegmina; the anal veins are very numerous, mostly simple and arcuate, less so and more crowded away from the anal furrow. The anal and internomedian veins are delicately traced, the others more pronounced; the whole surface is carbonaceous black, and shows nowhere any sign of cross lines.

Length of tegmina, 16.75 mm.; breadth, 6.25 mm.

This species resembles the Triassic species more than do any of the other Paleozoic forms, but it differs widely from them and indeed from all the others in the crowded venation, and in the complicated distribution of the externomedian branches.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2135 *a-b*.

16. Genus PETRABLATTINA.

Petrablattina Scudd., Mem. Bost. Soc. Nat. Hist., III, 123-124 (1879); Foss. Ins. N. A., I, 143-144 (1890).

This is a second genus found both in Paleozoic and Mesozoic rocks. One Triassic species formerly referred here really belongs in *Poroblattina* (*P. meieri*), but *Petrabl. aqua* from the same rocks undoubtedly belongs here. One of the other two American species, like the single European species, occurs in the Permian (of West Virginia); the other, on the contrary, is a far older form, coming from probably the Lowest Productive Coal-measures in the Acadian coal basin, near the upper limit of the Millstone Grit.

Table of the species of Petrablattina.

- a*¹. Mediastinal area reaching much beyond the middle of the tegmina; internomedian area wholly within the basal half of the tegmina..... 1. *P. sepulta*.
- a*². Mediastinal area reaching scarcely or not beyond the middle of the tegmina; internomedian area extending more or less into the distal half of the tegmina.
- b*¹. Scapular vein terminating at the tip of the tegmina; internomedian area reaching but little beyond the middle of the tegmina 2. *P. hastata*.
- b*². Scapular vein terminating far before the tip of the tegmina; internomedian area reaching well beyond the middle of the tegmina..... 3. *P. aqua*.

1. PETRABLATTINA SEPULTA.

Blattina sepulta Scudd., Proc. Amer. Assoc. Adv. Sc., XXIV, B, 111, fig. 2 (1876); Can. Nat., n. s., VIII, 89-90, fig. 2 [1] (1876).

Petrablattina sepulta Scudd., Mem. Bost. Soc. Nat. Hist., III, 125-126, pl. 6, fig. 7 (1879); Foss. Ins. N. A., I, 145-146, pl. 6, fig. 7 (1890).

From the very Lowest Productive Coal-measures of Sydney, Cape Breton Island.

2. PETRABLATTINA HASTATA.

Pl. XI, fig. 10.

The tegmina are of a subtriangular shape, about two and one-half times longer than broad, tapering rather rapidly almost from the base, the costal margin gently convex, the inner margin nearly straight. The apex is broken in the only specimen seen, but must have been more or less pointed, and probably rounded as represented in the figure. The mediastinal area is moderately broad and short, not extending to the middle of the tegmina, with five or six mostly simple, nearly straight, oblique branches. The scapular vein is broadly sinuous, running beyond the proximal third of the tegmina, through the middle of the same, and terminating at or scarcely above the apex; it branches early, before the end of the proximal third of the tegmina, the first branch simple, the others compound or forked, so that probably ten or twelve nervules strike the margin, and all are nearly longitudinal. The externomedian vein is strongly and pretty regularly arcuate, striking the inner margin scarcely beyond a point opposite the tip of the mediastinal vein, and having three simple or apically forked branches which are nearly longitudinal, but descend slightly toward the inner margin, the proximal branch arising well beyond the middle of the vein. The internomedian vein is parallel to the externomedian and has but two forked and arcuate branches. The anal furrow is similarly arcuate, rather deeply impressed, and strikes the margin a little beyond a point opposite the first branching of the scapular vein; the anal veins are numerous and rather deeply forked, more closely crowded proximally than distally, and, from forking, more crowded next the margin than away from it. The internomedian and anal veins, and especially the former, are very delicately traced, while the others are rather heavily impressed; the whole surface is uniformly coal black, and there is no trace of other sculpture than the venation.

Length of fragment, 6.5 mm.; probable length of tegmina, 8.25 mm.; breadth at end of anal furrow, 3.5 mm.

In the form of the tegmina *P. hastata* differs decidedly from either of the other species of the genus, but in its neurulation it agrees better with the Carboniferous than with the Triassic species; all three species are widely different. It is the smallest Paleozoic cockroach known from this country.

From the Waynesburg coal (Lower Permian) of Cassville, W. Va. Mr. R. D. Lacoe; one specimen, No. 2133 *a-b*.

3. PETRABLATTINA ÆQUA.

Petrablattina æqua Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 38 (1885); Mem. Bost.¹ Soc. Nat. Hist., IV, 465, pl. 42, fig. 13¹ (1890); Foss. Ins. N. A., I, 441, pl. 34, fig. 13. (1890).

Trias of Fair Play, Colo.

¹ Erroneously marked 9 on the plate. See note to p. 87.

Genus LEPTOBLATTINA.

Leptoblattina Woodw., Geol. Mag., Dec. iii, Vol. IV, 58 (1887).

This is an exclusively European type of cockroach. Two species are known, one from the very oldest true Coal-measures, the other possibly from the same or slightly younger rocks.

DESCRIPTION OF THE HIND WING OF A GIGANTIC SPECIES.

BLATTINA sp.

Pl. X, fig. 16.

A single specimen of a hind wing of enormous size differs so much from any other known that I use for it, as a convenience merely, the old generic term *Blattina*, as applied to fossil cockroaches in general. It is nearly complete, and shows that the costal margin was gently and nearly uniformly arcuate, the inner margin very strongly and probably uniformly arcuate, the apex falling scarcely below the middle of the upper half of the wing and subacuminate but well rounded. The mediastinal vein is straight, runs very near to and parallel with the margin, and terminates almost at the distal end of the middle third of the wing; the area is broken so that only a couple of apical branches can be seen. The scapular vein is almost rigidly straight and terminates at some distance below the extreme apex of the wing, divides at the very root into two main branches which again fork in the basal fourth of the wing; the branchlets of both are superior, those of the upper stem much the more numerous and often compound, those of the lower feeding that part of the margin lying below the apex and all longitudinal, those of the upper stem apically arcuate, especially in their terminal members. The externomedian vein is straight and runs through nearly the middle line of the wing, gradually passing into the lower half by its divergence from the scapular, first forks at about the end of the proximal third of the wing, and thereafter sends out arcuate sublongitudinal offshoots on either side indiscriminately, which do not fork before their middle. The internomedian vein is bent-arcuate, subparallel to the externomedian before that forks, is then bent, and ends a very little farther out than the mediastinal vein; it has only a couple of very oblique branches, the the distal one twice deeply forked. No anal veins can be traced. The interspaces near the apex show a somewhat irregular tremulous cross lining, not very crowded.

Length of fragment, 47 mm.; probable length of entire wing, 51 mm.; breadth of fragment, 24.5 mm.; probable complete breadth, 25.25 mm.

The complete correspondence of the long mediastinal area in this wing to that of *Etoblattina* in the few examples known, and the strong probability that the area in question will be found to be very short and perhaps triangular in the *Mylacridæ*, lead me to believe that this wing should be referred to the *Blattinariæ* and not to the *Mylacridæ*. Its

excessive size, which shows it to belong to one of the largest fossil cockroaches yet discovered, would at first seem to recall the Mylacridæ, but it should not be forgotten that some species of Etoblattina, such as *E. didyma* and notably *E. illustris*, rival the largest Mylacridæ known. The only two species of Etoblattina known from the same fauna as this wing are of only about one-half its size. It plainly, therefore, belongs to a species, the tegmina of which are yet undescribed. Its variance from what we know of the hind wings of Etoblattina, however, prevent our placing it, at least for the present, in that genus, and it seems best to refer it simply to "Blattina," as a "magazine" genus.

From the Lowest Productive Coal-measures of Mazon Creek, Illinois. Mr. R. D. Lacoe, No. 2038a.

NEOBLATTARIÆ

With a few Triassic exceptions, this division embraces all the cockroaches which are known from later than Paleozoic times.

17. Genus NEORTHROBLATTINA.

Neorthroblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 108-109 (1885).

A genus confined, as far as known, to the Triassic rocks. Four species have been found in central Colorado.

Table of the species of Neorthroblattina.

- a*¹. Fore wings not more than two and one-half times as long as broad; mediastino-scapular vein terminating only a little before the tip of the tegmina.
- b*¹. Internommedian vein beginning to fork long before the externommedian and of equal importance with it 1. *N. albolineata*.
- b*². Internommedian vein beginning to fork scarcely or not before the externommedian and of less importance than it.
- c*¹. Internommedian area terminating much farther from the apex of the tegmina than the mediastino-scapular 2. *N. lakesii*.
- c*². Internommedian area reaching out toward the apex of the tegmina nearly as far as the mediastino-scapular 3. *N. rotundata*.
- a*². Fore wings about three times as long as broad; mediastino-scapular area terminating long before the tip of the tegmina 4. *N. attenuata*.

1. NEORTHROBLATTINA ALBOLINEATA.

Neorthroblattina albolineata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 109 (1885); Mem. Bost. Soc. Nat. Hist., IV, 467, pl. 42, figs. 2, 18 (1890); Foss. Ins. N. A., I, 336, 443, pl. 34, figs. 2, 18 (1890).

Triassic of Fair Play, Colo.

2. NEORTHROBLATTINA LAKESII.

Neorthroblattina lakesii Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 109 (1885); Mem. Bost. Soc. Nat. Hist., IV, 467, 468, pl. 42, figs. 9, 15¹ (1890); Foss. Ins. N. A., I, 336, 443, 444, pl. 34, figs. 9, 15¹ (1890).

Triassic of Fair Play, Colo.

¹Erroneously marked 10 and 16 on plate. See note on p. 87.

3. NEORTHROBLATTINA ROTUNDATA.

Neorthroblattina rotundata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 109-110 (1885); Mem. Bost. Soc. Nat. Hist., IV, 467, 468, pl. 42, figs. 7, 8 (1890); Foss. Ins. N. A., I, 336, 443, 444, pl. 34, figs. 7, 8 (1890).

Triassic of Fair Play, Colo.

4. NEORTHROBLATTINA ATTENUATA.

Neorthroblattina attenuata Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 110 (1885); Mem. Bost. Soc. Nat. Hist., IV, 467, 468-469, pl. 42, fig. 1 (1890); Foss. Ins. N. A., I, 336, 443, 444-445, pl. 34, fig. 1 (1890).

Triassic of Fair Play, Colo.

18. Genus SCUTINOBLATTINA.

Scutinoblattina Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 110 (1885).

A second genus confined, as yet known, to the Trias and to central Colorado, where three species occur.

Table of the species of Scutinoblattina.

- a*¹. Mediastino-scapular and externomedian veins having a distinctly sinuous course through the middle of the tegmina, both terminating below the apex.
- b*¹. Anal branches falling on the hind margin..... 1. *S. brongniarti*.
- b*². Anal branches falling on the anal furrow..... 2. *S. intermedia*.
- a*². Mediastino-scapular and externomedian veins taking a straight course through the middle of the tegmina, both terminating at the tip 3. *S. recta*.

1. SCUTINOBLATTINA BRONGNIARTI.

Scutinoblattina brongniarti Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 110-111 (1885); Mem. Bost. Soc. Nat. Hist., IV, 469, pl. 42, fig. 5 (1890); Foss. Ins. N. A., I 370, 445, pl. 34, fig. 5 (1890).

Triassic of Fair Play, Colo.

2. SCUTINOBLATTINA INTERMEDIA.

Scutinoblattina intermedia Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 111 (1885); Mem. Bost. Soc. Nat. Hist., IV., 469, 470, pl. 42, fig. 4 (1890); Foss. Ins. N. A., I, 370, 445, 446, pl. 34, fig. 4 (1890).

Triassic of Fair Play, Colo.

3. SCUTINOBLATTINA RECTA.

Scutinoblattina recta Scudd., Proc. Acad. Nat. Sc. Philad., 1885, 111, (1885); Mem. Bost. Soc. Nat. Hist., IV, 469, 470, pl. 42, fig. 3, 16¹ (1890); Foss. Ins. N. A., I, 370, 445, 446, pl. 34, figs. 3, 16¹ (1890).

Triassic of Fair Play, Colo.

¹Erroneously marked 17 on plate. See note on p. 87.

20. Genus ZETOBORA.

Zetobora Burm., Handb. Entom., II, 509-510 (1838).

An extant genus, recognized in the Tertiary rocks of Colorado.

ZETOBORA BRUNNERI.

Zetobora brunneri Scudd., Tert. Ins. N. A., 217, pl. 17, fig. 12 (1890).

Tertiary of Florissant, Colo.

19. Genus HOMŒOGAMIA.

Homœogamia Burm., Handb. Entom., II, 490 (1838).

A tropical American living type of cockroaches; also recognized in the Tertiary of Colorado by a single species.

HOMŒOGAMIA VENTRIOSUS.

Homœogamia ventriosus Scudd., Bull. U. S. Geol. Surv. Terr., I, 447 (1876); Tert. Ins. N. A., 218, pl. 17, fig. 8 (1890).

Tertiary of Florissant, Colo.

21. Genus PARALATINDIA.

Parlatindia Sauss., Rev. Mag. Zool., XXXI, 100-101 (1868).

A distinctively American type of living cockroaches, of which one fossil species occurs in the Tertiaries of Wyoming.

PARALATINDIA SAUSSUREI.

Paralatindia saussurei Scudd., Tert. Ins. N. A., 216, pl. 6, fig. 25 (1890).

Tertiary of Green River, Wyoming.

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PLATES

PLATE I.

EXPLANATION OF PLATE I.

Figs. 1 and 4 are from the originals of the Illinois geological survey. Figs. 2, 3, and 5 were drawn by J. Henry Blake; fig. 6 by J. H. Emerton. All the figures are magnified two diameters, excepting figs. 1 and 4, which are of natural size.

Fig. 1. *Mylacris anthracophila*; pronotum. Colchester, Ill.

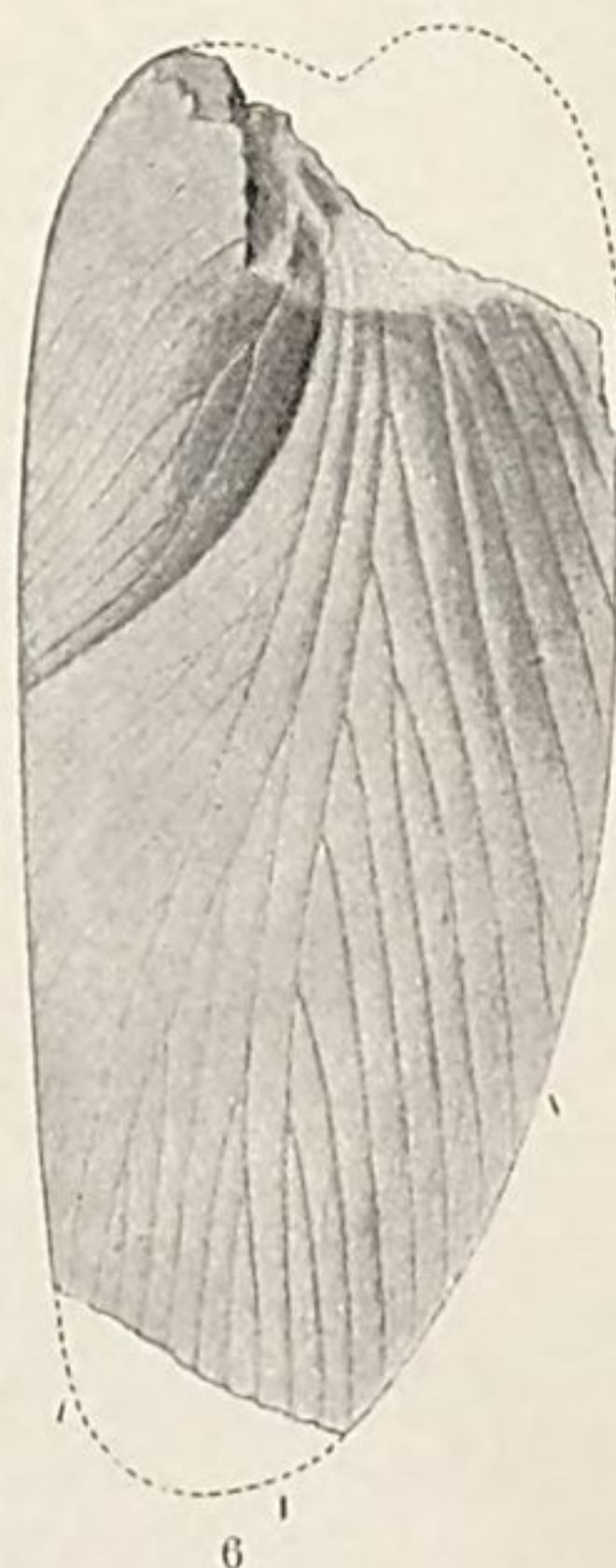
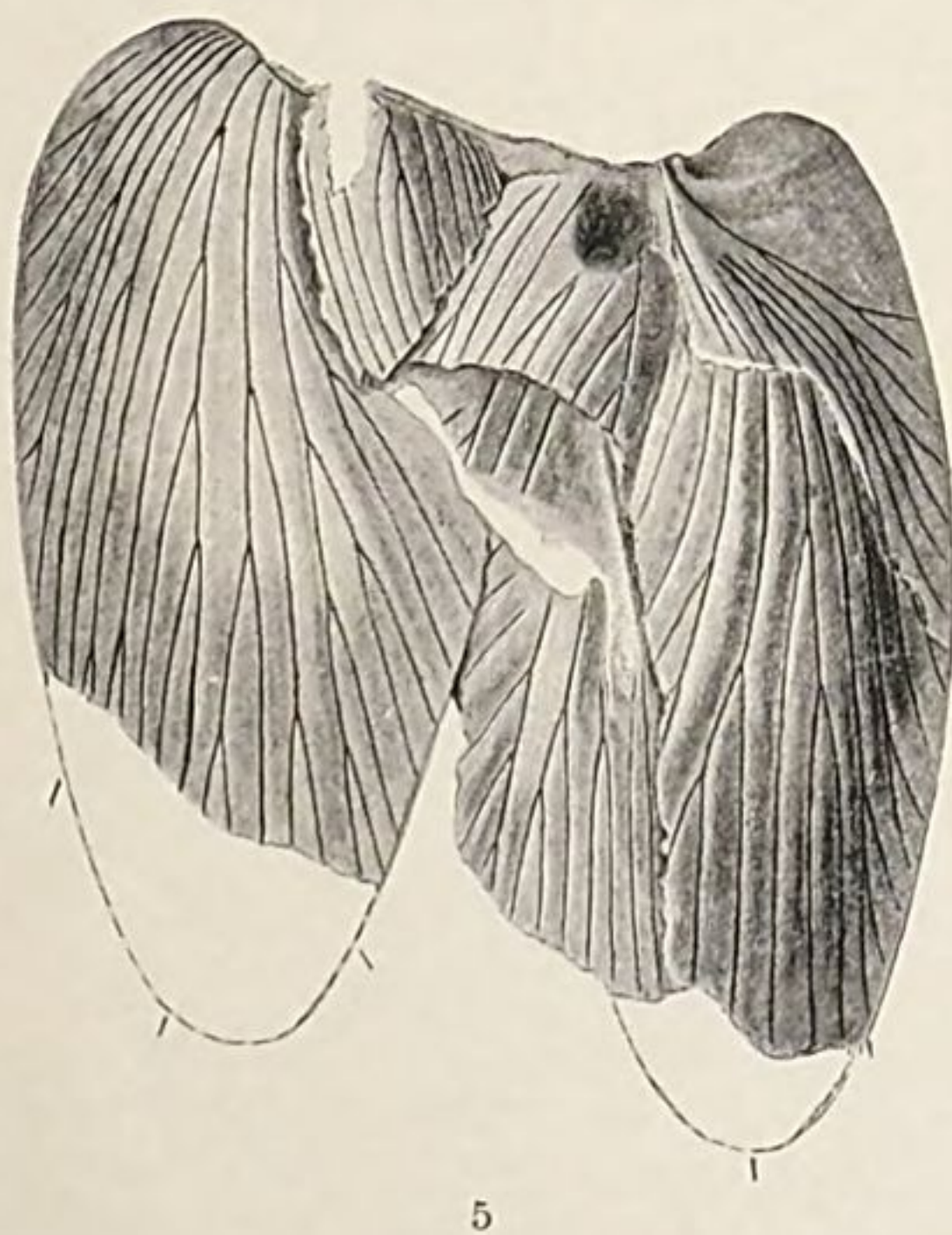
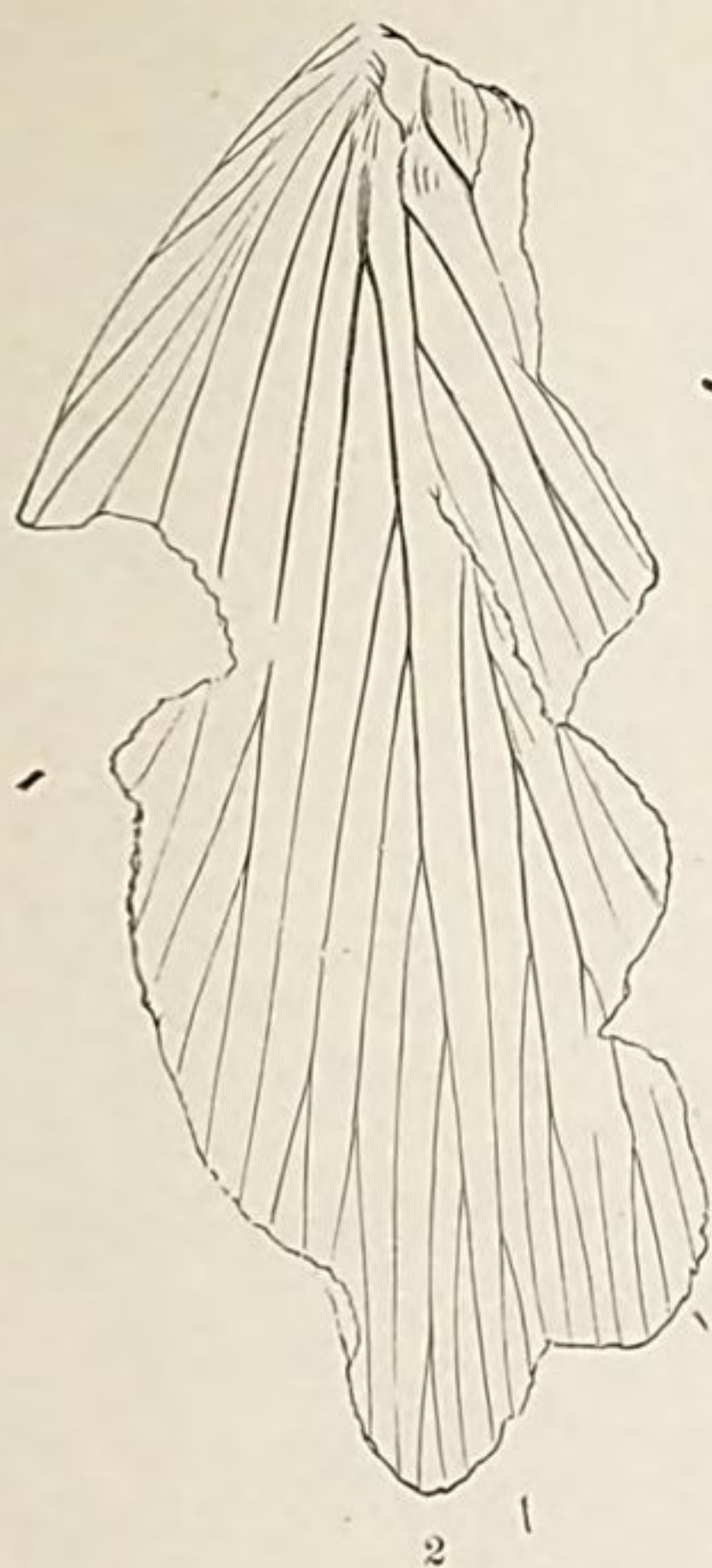
2. *Mylacris packardii*. Bristol, R. I.

3. *Mylacris packardii*. Bristol, R. I.

4. *Mylacris anthracophila*; one of the tegmina. Colchester, Ill.

5. *Mylacris gurleyi*. Mazon Creek, Illinois.

6. *Mylacris elongata* (2014). Mazon Creek, Illinois.



MYLACRIDÆ: SPECIES OF MYLACRIS.

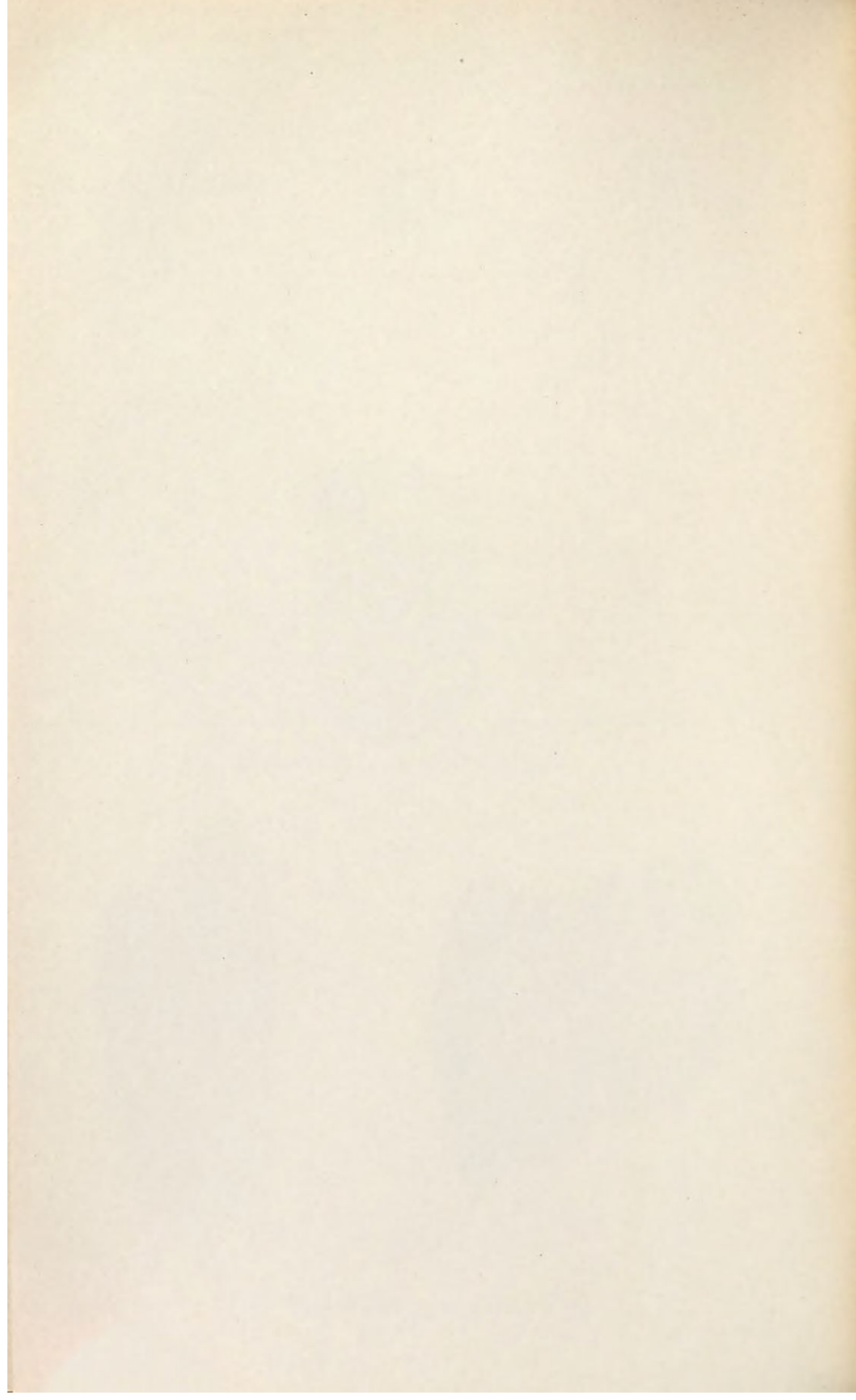
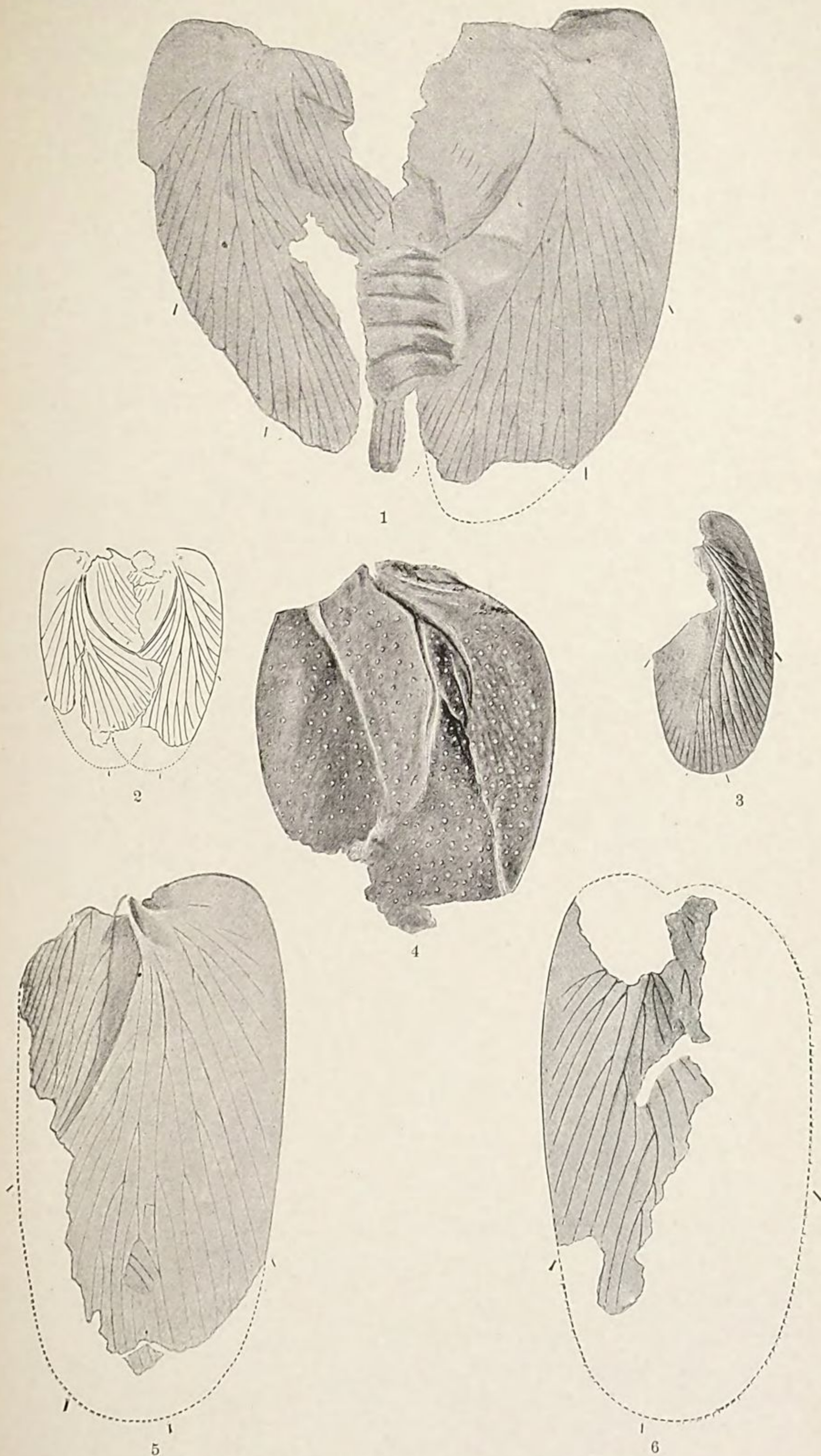


PLATE II.

EXPLANATION OF PLATE II.

Figs. 2 to 4 were drawn by J. Henry Blake; the others by Katherine Peirson Ramsay. All are magnified two diameters.

- Fig. 1. *Mylacris ampla* (2021). Mazon Creek, Illinois.
2. *Promylacris testudo* (2089). Mazon Creek, Illinois.
3. *Promylacris harei* (2087). Kansas City, Mo.
4. *Mylacridæ* sp. Mazon Creek, Illinois.
5. *Mylacris antiqua* (2036*a*). Mazon Creek, Illinois.
6. *Mylacris antiqua* (2036*b*). Mazon Creek, Illinois.



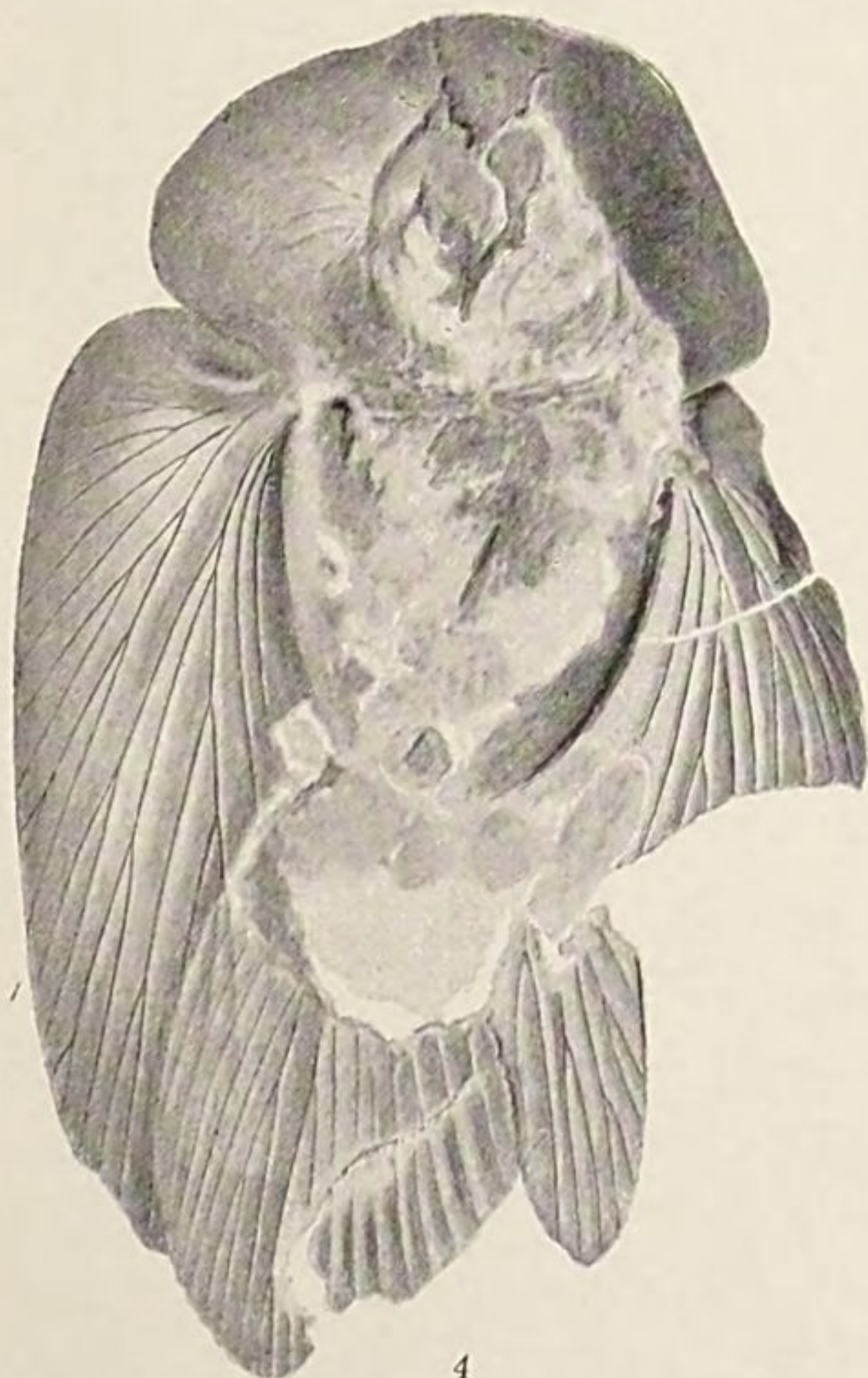
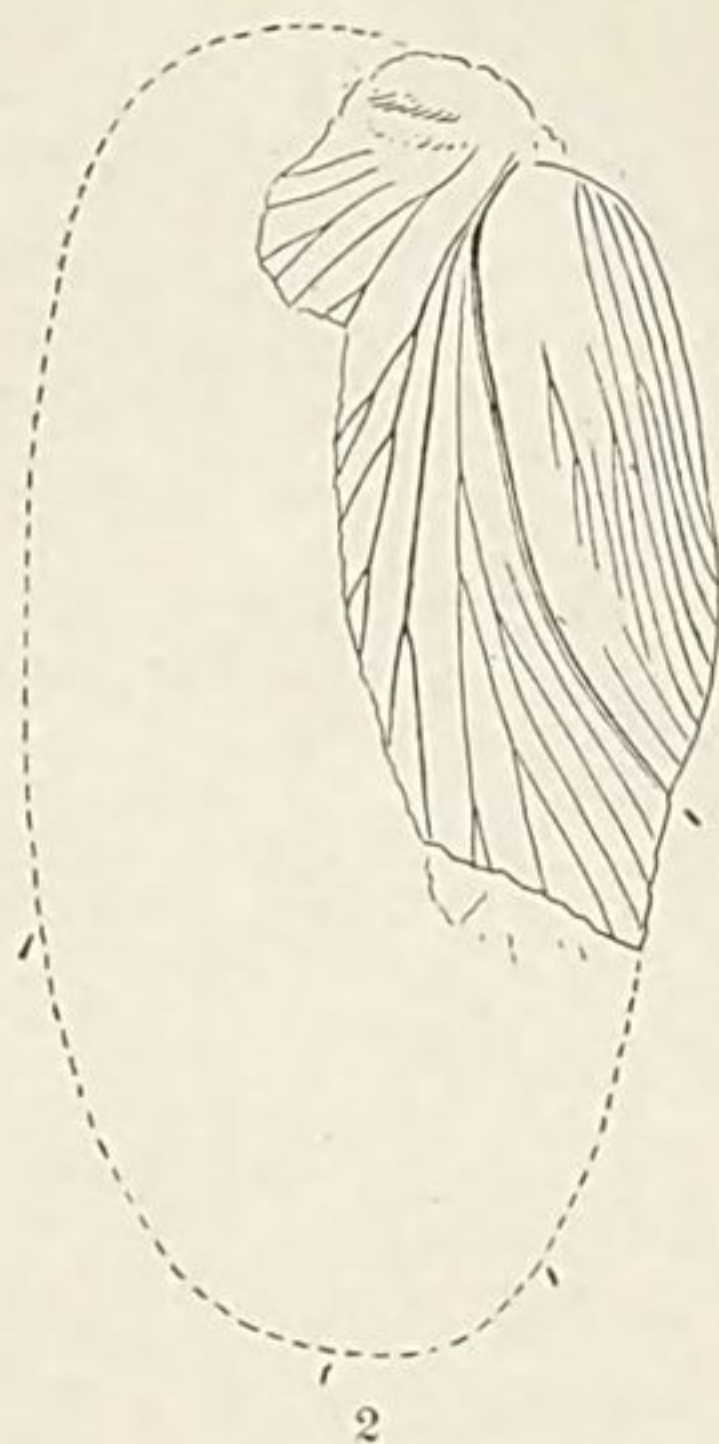
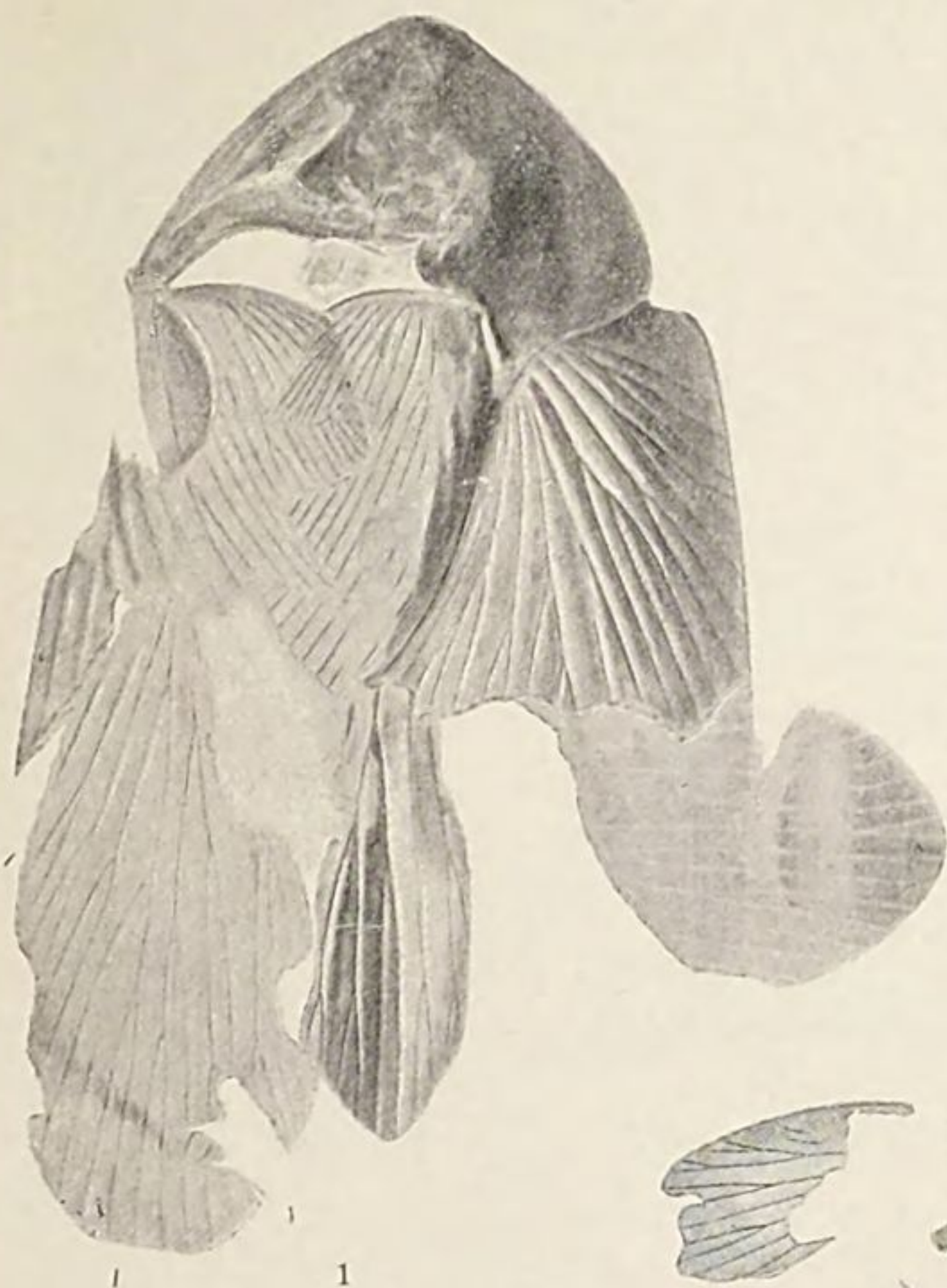
MYLACRIDÆ: SPECIES OF MYLACRIS AND PROMYLACRIS.

PLATE III.

EXPLANATION OF PLATE III.

All the drawings are by J. Henry Blake, and magnified two diameters.

- Fig. 1. *Promylacris rigida* (2086). Mazon Creek, Illinois.
2. *Paromylacris* ? *pluteus* (2040). Pittston, Pa.
3. *Paromylacris triangularis* (2110). Mazon Creek, Illinois.
4. *Paromylacris ampla* (2088). Mazon Creek, Illinois.
5. *Microblattina perdita* (2092). East Providence, R. I.
6. *Paromylacris clintoniana* (2151). Clinton, Mo.



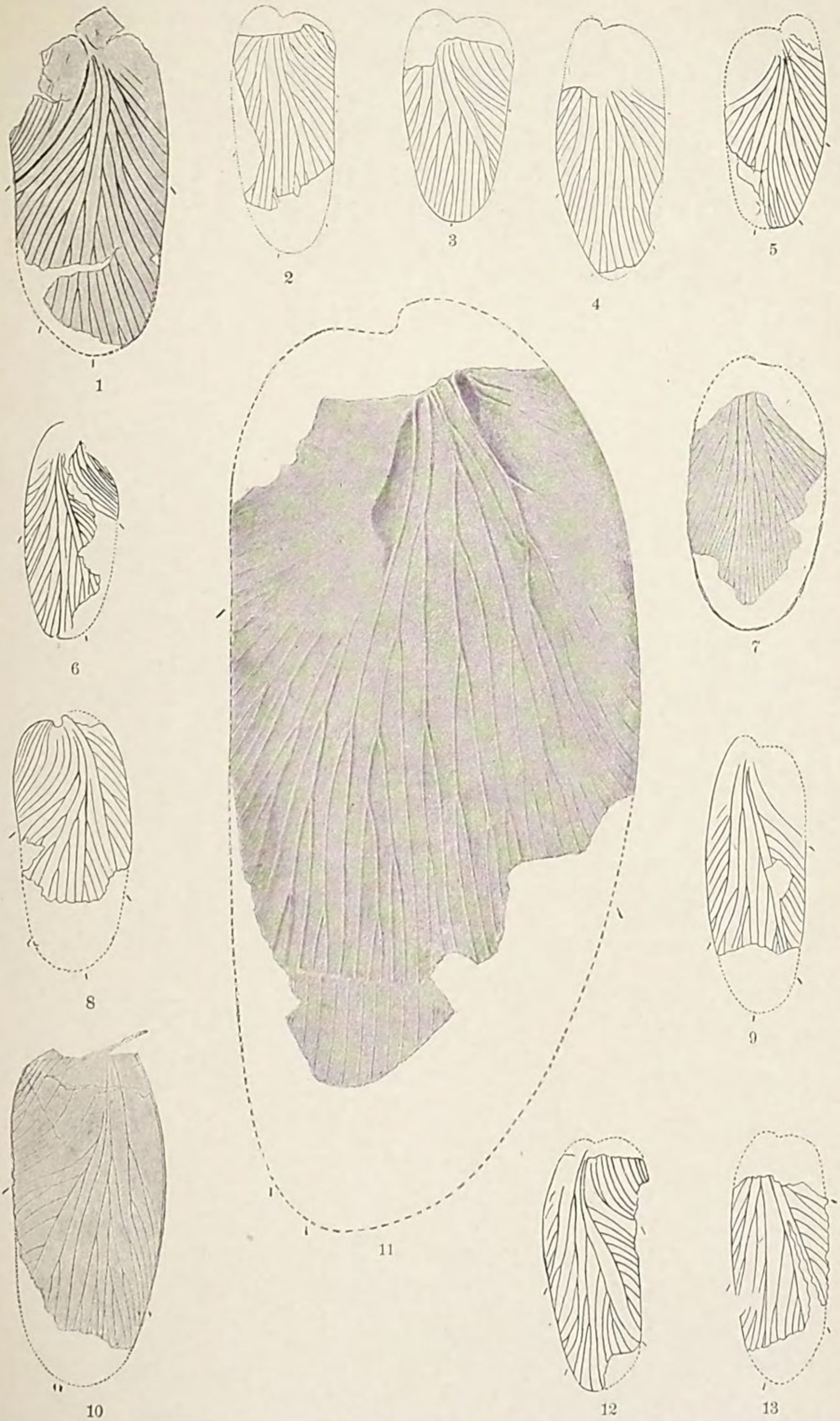
MYLACRIDÆ: SPECIES OF PROMYLACRIS AND PAROMYLACRIS.
BLATTINARIÆ: SPECIES OF MICROBLATTINA.

PLATE IV.

EXPLANATION OF PLATE IV.

All the drawings are by J. Henry Blake, excepting figs. 2 to 4 by S. H. Scudder, and fig. 10 by J. H. Emerton. All are magnified two diameters.

- Fig. 1. *Etoblattina clintoniana* (2182). Clinton, Mo.
2. *Etoblattina lata* (2099). Cassville, W. Va.
3. *Etoblattina sagittaria* (2100). Cassville, W. Va.
4. *Etoblattina mediana* (2101). Cassville, W. Va.
5. *Etoblattina fossa* (182). Richmond, Ohio.
6. *Etoblattina ovata* (2102). Cassville, W. Va.
7. *Etoblattina scholfieldi*. East Providence, R. I.
8. *Etoblattina debilis* (2103). Cassville, W. Va.
9. *Etoblattina patiens* (2104). Cassville, W. Va.
10. *Etoblattina strigosa*. Richmond, Ohio.
11. *Etoblattina illustris*. Pawtucket (?), R. I.
12. *Etoblattina detecta* (2106*a*). Cassville, W. Va.
13. *Etoblattina detecta* (2106*c*). Cassville, W. Va.



BLATTINARIÆ: SPECIES OF ETOBLATTINA.

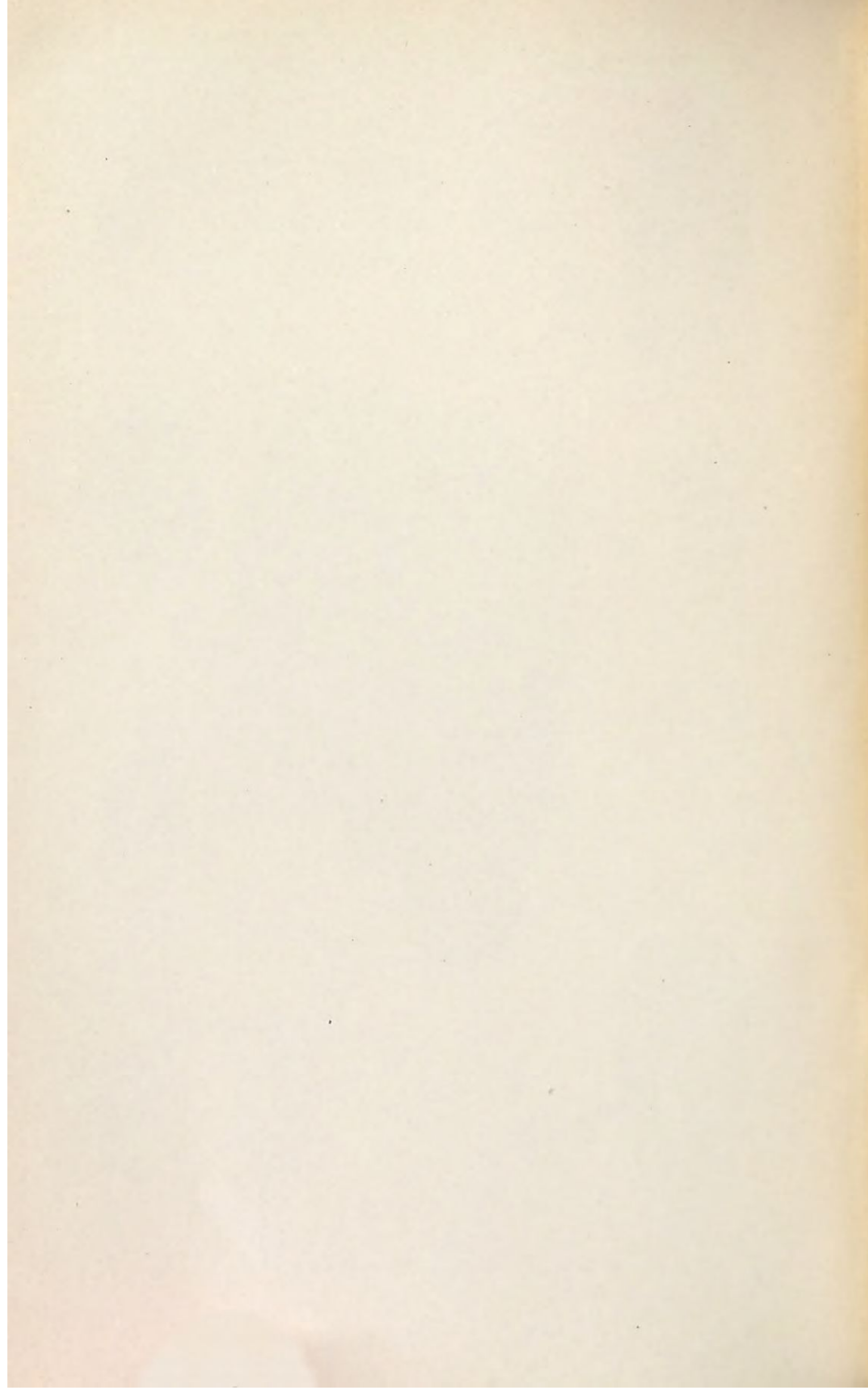
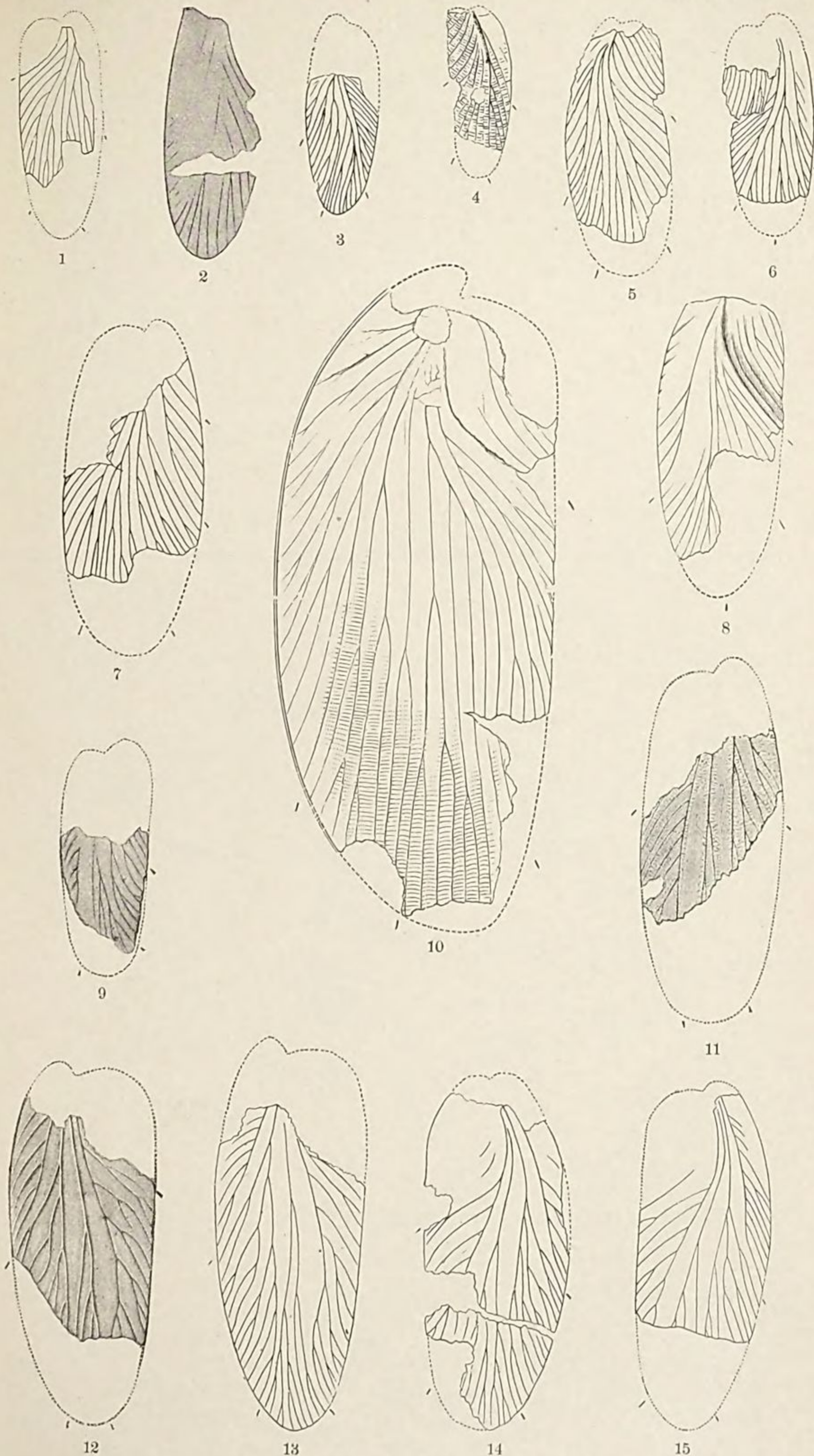


PLATE V.

EXPLANATION OF PLATE V.

All the drawings are by J. Henry Blake, excepting figs. 9, 11, 12 by J. H. Emerton, and figs. 1 and 15 by S. H. Scudder. All are enlarged two diameters.

- Fig. 1. *Etoblattina residua* (2131). Cassville, W. Va.
2. *Etoblattina* sp. Pawtucket, R. I.
3. *Etoblattina mucronata* (2105). Cassville, W. Va.
4. *Etoblattina exigua* (2107). Cassville, W. Va.
5. *Etoblattina funeraria* (2108). Cassville, W. Va.
6. *Etoblattina expuncta* (2109). Cassville, W. Va.
7. *Etoblattina jeffersoniana* (194). Richmond, Ohio.
8. *Etoblattina gorhami*. Pawtucket, R. I.
9. *Etoblattina aperta* (2066). Cassville, W. Va.
10. *Etoblattina clarkii*. Pawtucket, R. I.
11. *Etoblattina fasciata*. Richmond, Ohio.
12. *Etoblattina ramosa* (108). Richmond, Ohio.
13. *Etoblattina willsiana* (176). Richmond, Ohio.
14. *Etoblattina benedicta* (183). Richmond, Ohio.
15. *Etoblattina benedicta* (178). Richmond, Ohio.



BLATTINARIÆ: SPECIES OF ETOBLATTINA.

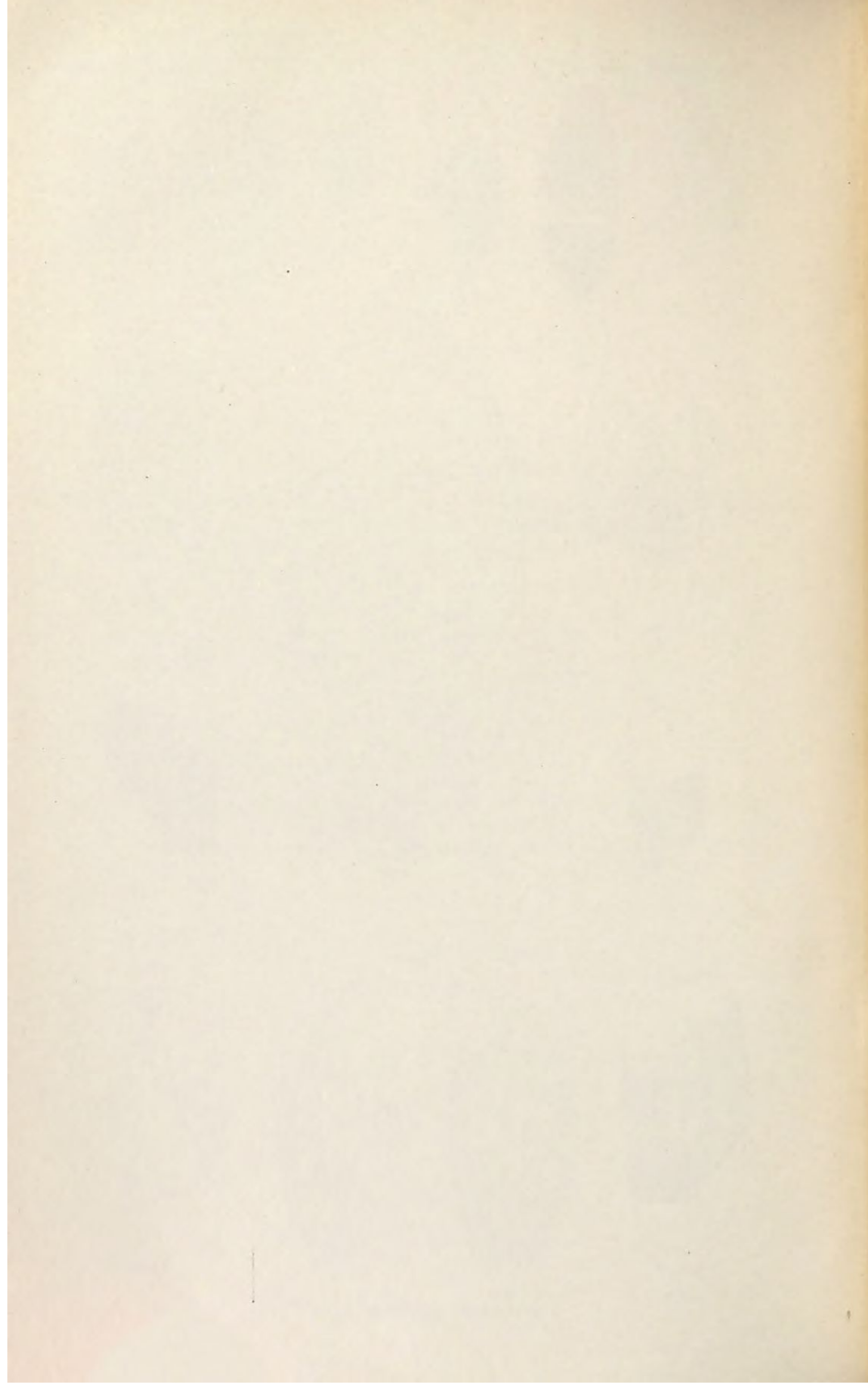


PLATE VI.

EXPLANATION OF PLATE VI.

All the drawings are by Katherine Peirson Ramsay, excepting figs. 4 and 6 by J. H. Emerton, and figs. 5 and 8 by J. Henry Blake. All are magnified two diameters.

- Fig. 1. *Etoblattina maledicta* (174). Richmond, Ohio.
2. *Etoblattina maledicta* (163). Richmond, Ohio.
3. *Etoblattina maledicta* (164). Richmond, Ohio.
4. *Etoblattina funesta* (107). Richmond, Ohio.
5. *Etoblattina mazona*. Mazon Creek, Illinois.
6. *Etoblattina tenuis*. Richmond, Ohio.
7. *Etoblattina exsensa* (161). Richmond, Ohio.
8. *Etoblattina exsensa* (196). Richmond, Ohio.
9. *Etoblattina hustoni* (122). Richmond, Ohio.



BLATTINARIÆ: SPECIES OF ETOBLATTINA.

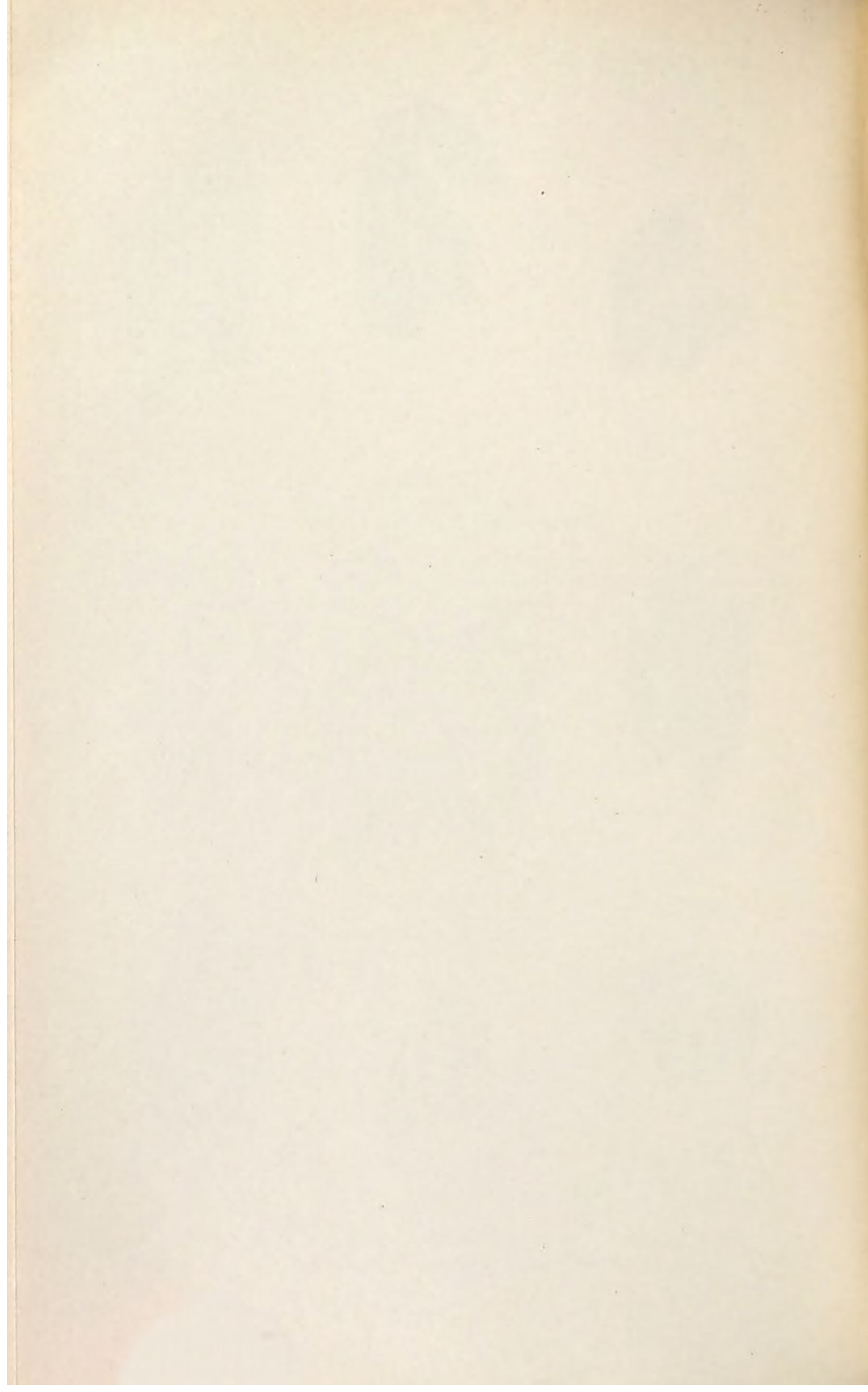


PLATE VII.

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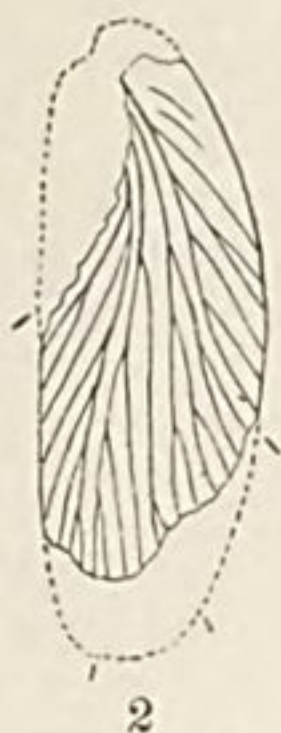
EXPLANATION OF PLATE VII.

All the drawings are by J. Henry Blake, excepting figs. 6, 10, 14 to 17 by Katherine Peirson Ramsay, and fig. 13 by S. H. Scudder. All are magnified two diameters.

- Fig. 1. *Etoblattina eakiniana* (2111). Cassville, W. Va.
2. *Etoblattina accubita* (2112). Cassville, W. Va.
3. *Etoblattina expulsata* (2113*a*). Cassville, W. Va.
4. *Etoblattina expulsata* (2113*c*). Cassville, W. Va.
5. *Etoblattina gratiosa* (2114). Cassville, W. Va.
6. *Etoblattina macerata* (2081). Cassville, W. Va.
7. *Etoblattina immolata* (2115*c*). Cassville, W. Va.
8. *Etoblattina immolata* (2115*a*). Cassville, W. Va.
9. *Etoblattina mactata* (2116). Cassville, W. Va.
10. *Etoblattina communis* (2117*h*). Cassville, W. Va.
11. *Etoblattina communis* (2117*e*). Cassville, W. Va.
12. *Etoblattina communis* (2117*o*). Cassville, W. Va.
13. *Etoblattina communis* (2117*a*). Cassville, W. Va.
14. *Etoblattina communis* (2117*e*). Cassville, W. Va.
15. *Etoblattina communis* (2117*g*). Cassville, W. Va.
16. *Etoblattina communis* (2117*f*). Cassville, W. Va.
17. *Etoblattina communis* (2117*i*). Cassville, W. Va.



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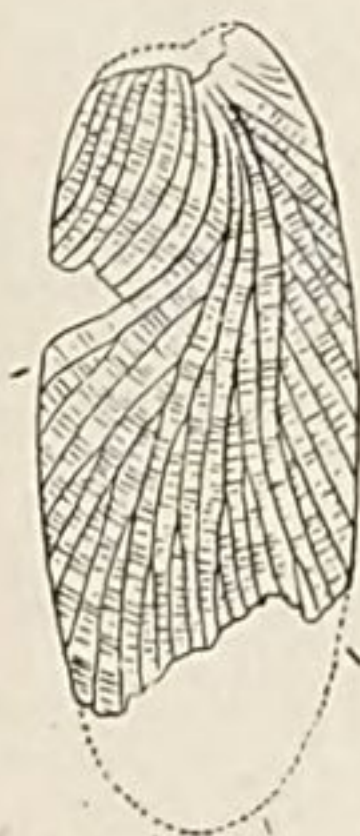
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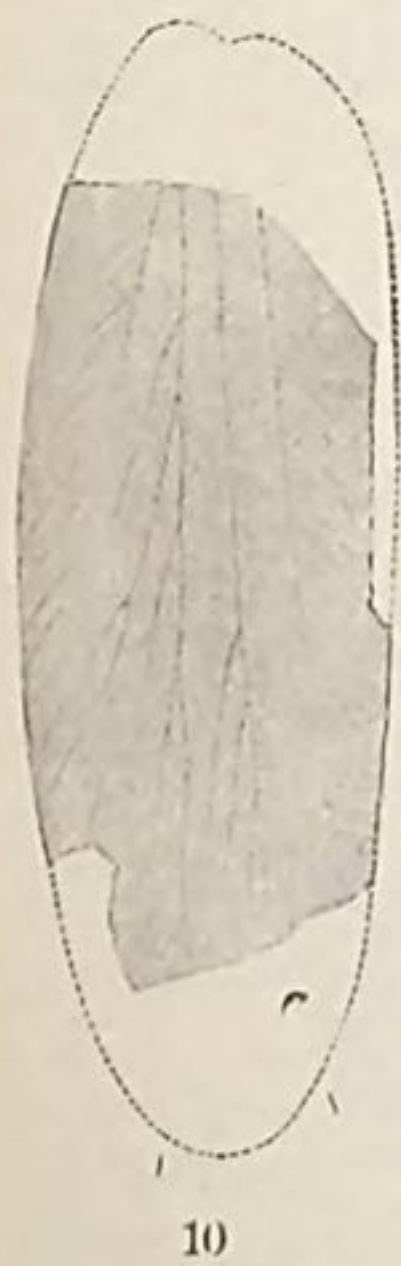
BLATTINARIÆ: SPECIES OF ETOBLATTINA.

PLATE VIII.

EXPLANATION OF PLATE VIII.

Figs. 4, 5, 7, 9, 12 are by J. Henry Blake; figs. 3, 8, 10, 11 by Katherine Peirson Ramsey, and figs. 1, 2, 6 by J. H. Emerton. All are magnified two diameters.

- Fig. 1. *Etoblattina hastata* (106). Richmond, Ohio.
2. *Etoblattina marginata* (117). Richmond, Ohio.
3. *Etoblattina stipata* (123). Richmond, Ohio.
4. *Etoblattina exsecuta* (2120). Cassville, W. Va.
5. *Etoblattina arcta* (2118). Cassville, W. Va.
6. *Etoblattina gracilenta* (114). Richmond, Ohio.
7. *Etoblattina gracilenta* (198). Richmond, Ohio.
8. *Etoblattina angusta* (2080). Cassville, W. Va.
9. *Etoblattina macilenta* (2121). Cassville, W. Va.
10. *Etoblattina variegata* (49). Richmond, Ohio.
11. *Etoblattina hilliana* (2070). Mazon Creek, Illinois.
12. *Etoblattina prædulcis* (2119). Cassville, W. Va.



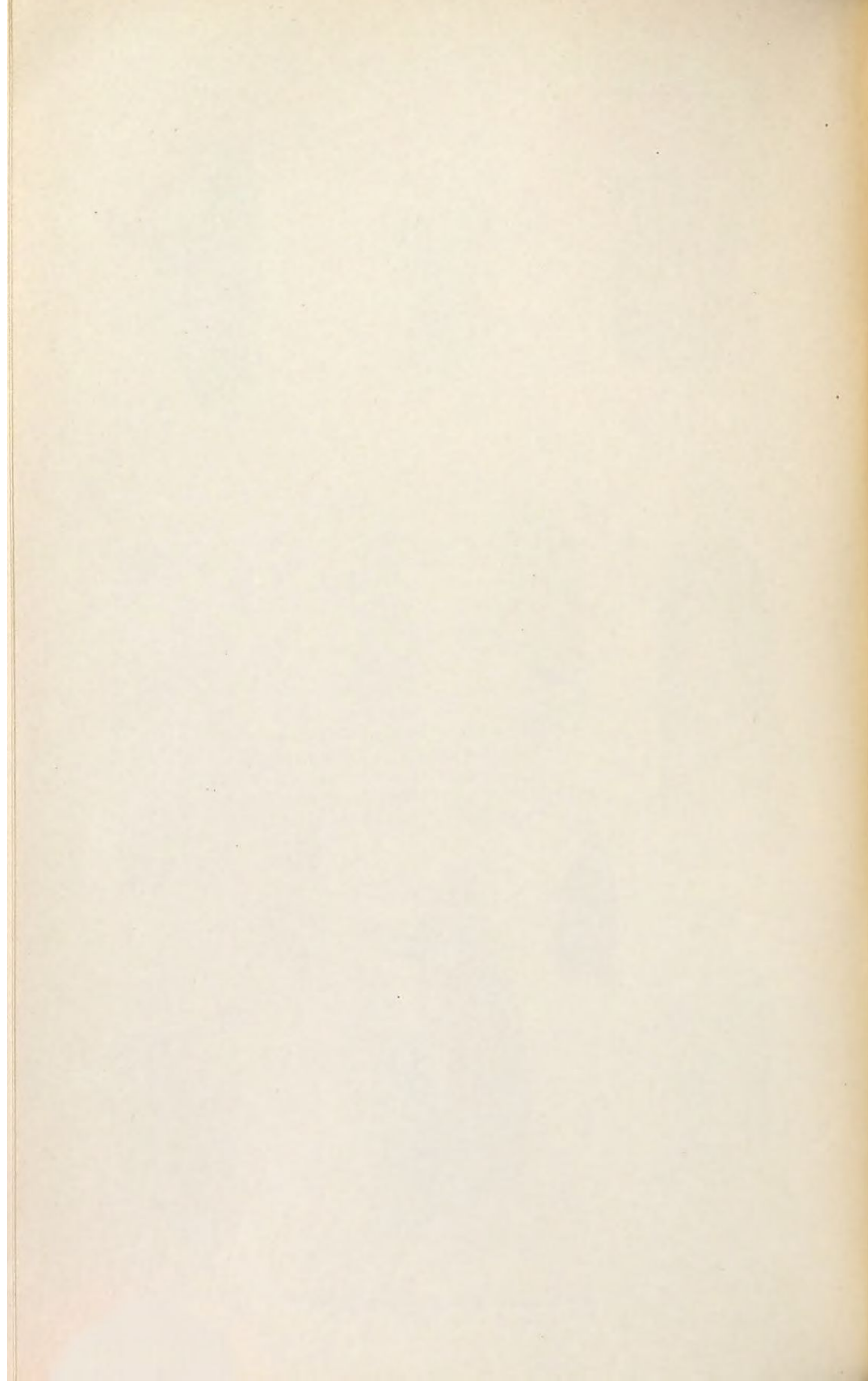
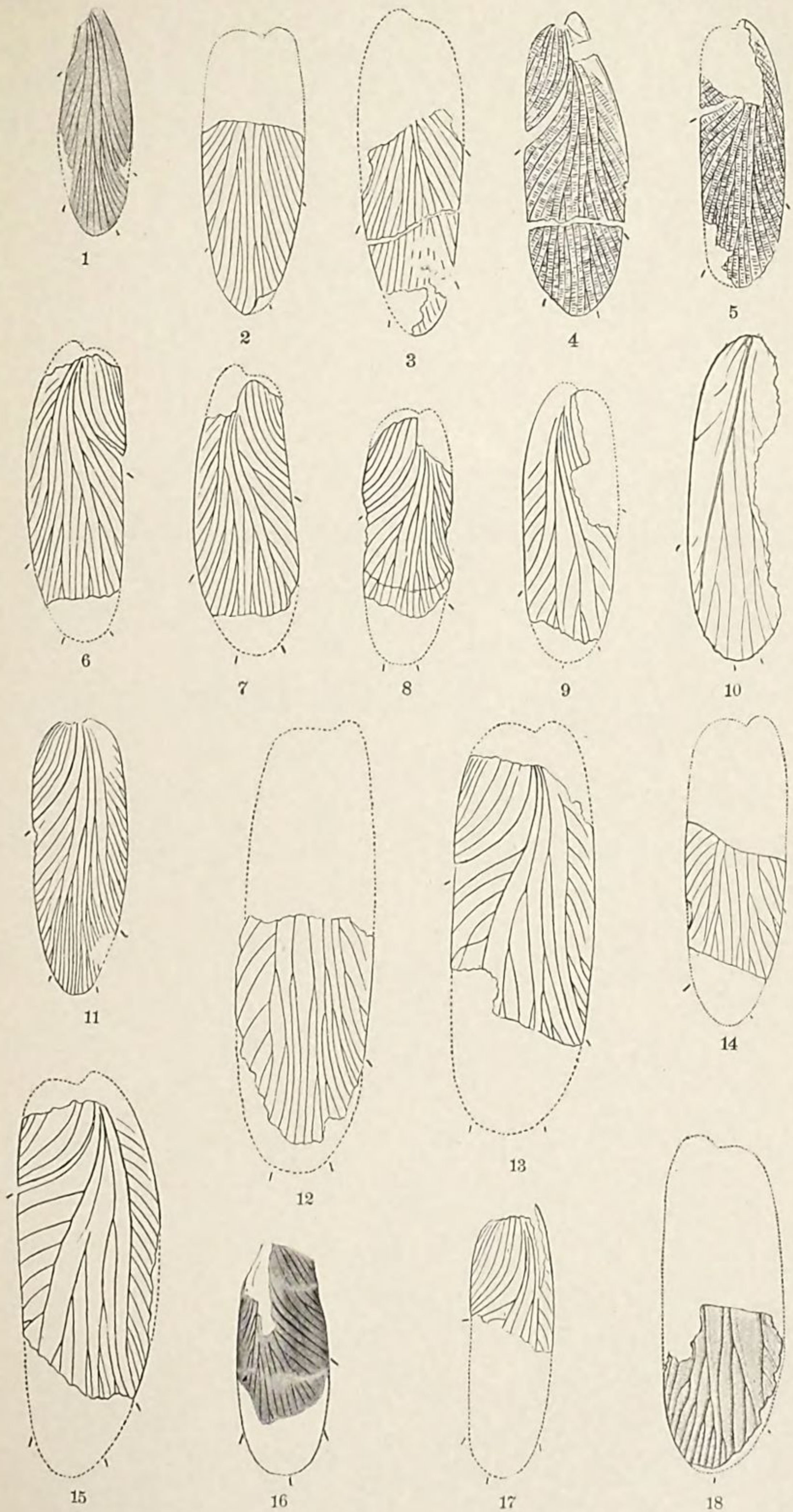


PLATE IX.

EXPLANATION OF PLATE IX.

All the drawings are by J. Henry Blake, excepting figs. 2 and 14 by S. H. Scudder, and fig. 18 by J. H. Emerton. All are magnified two diameters.

- Fig. 1. *Etoblattina exilis*. East Providence, R. I.
2. *Etoblattina rogi* (2122*b*). Cassville, W. Va.
3. *Etoblattina rogi* (2122*a*). Cassville, W. Va.
4. *Etoblattina expugnata* (2085). Cassville, W. Va.
5. *Etoblattina obatra* (2123). Cassville, W. Va.
6. *Etoblattina secreta* (2125*a*). Cassville, W. Va.
7. *Etoblattina secreta* (2125*c*). Cassville, W. Va.
8. *Etoblattina imperfecta* (2124). Cassville, W. Va.
9. *Etoblattina invis*a (2126). Cassville, W. Va.
10. *Etoblattina reliqua*. Pawtucket, R. I.
11. *Etoblattina latebricola* (2091). East Providence, R. I.
12. *Etoblattina defossa* (2128). Cassville, W. Va.
13. *Etoblattina occulta* (2127). Cassville, W. Va.
14. *Etoblattina recidiva* (2129). Cassville, W. Va.
15. *Gerablattina diversinervis* (2141). Cassville, W. Va.
16. *Gerablattina inculta* (2139). Cassville, W. Va.
17. *Gerablattina perita* (2140). Cassville, W. Va.
18. *Gerablattina apicalis* (112). Richmond, Ohio.



BLATTINARIÆ: SPECIES OF ETOBLATTINA AND GERABLATTINA.

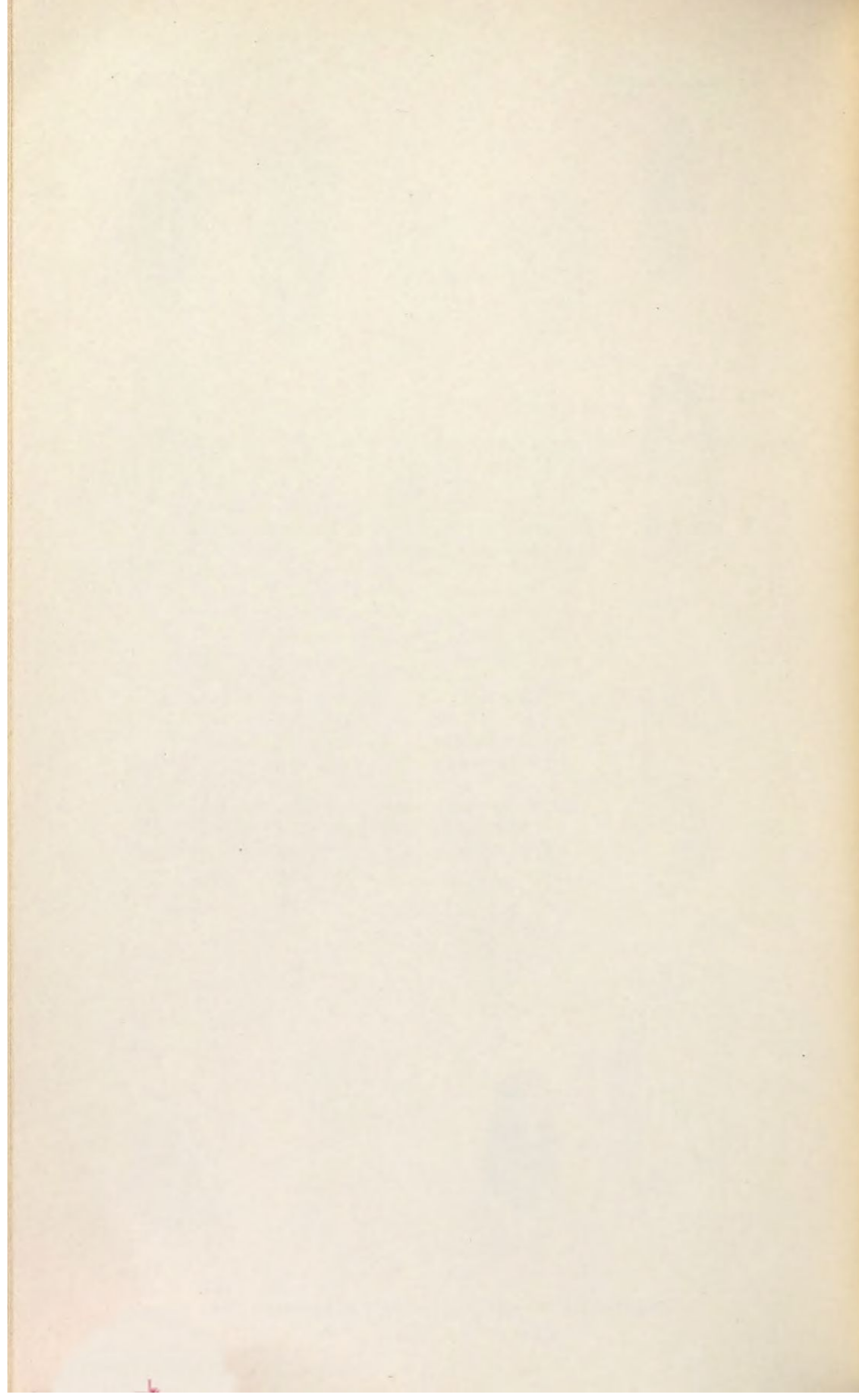


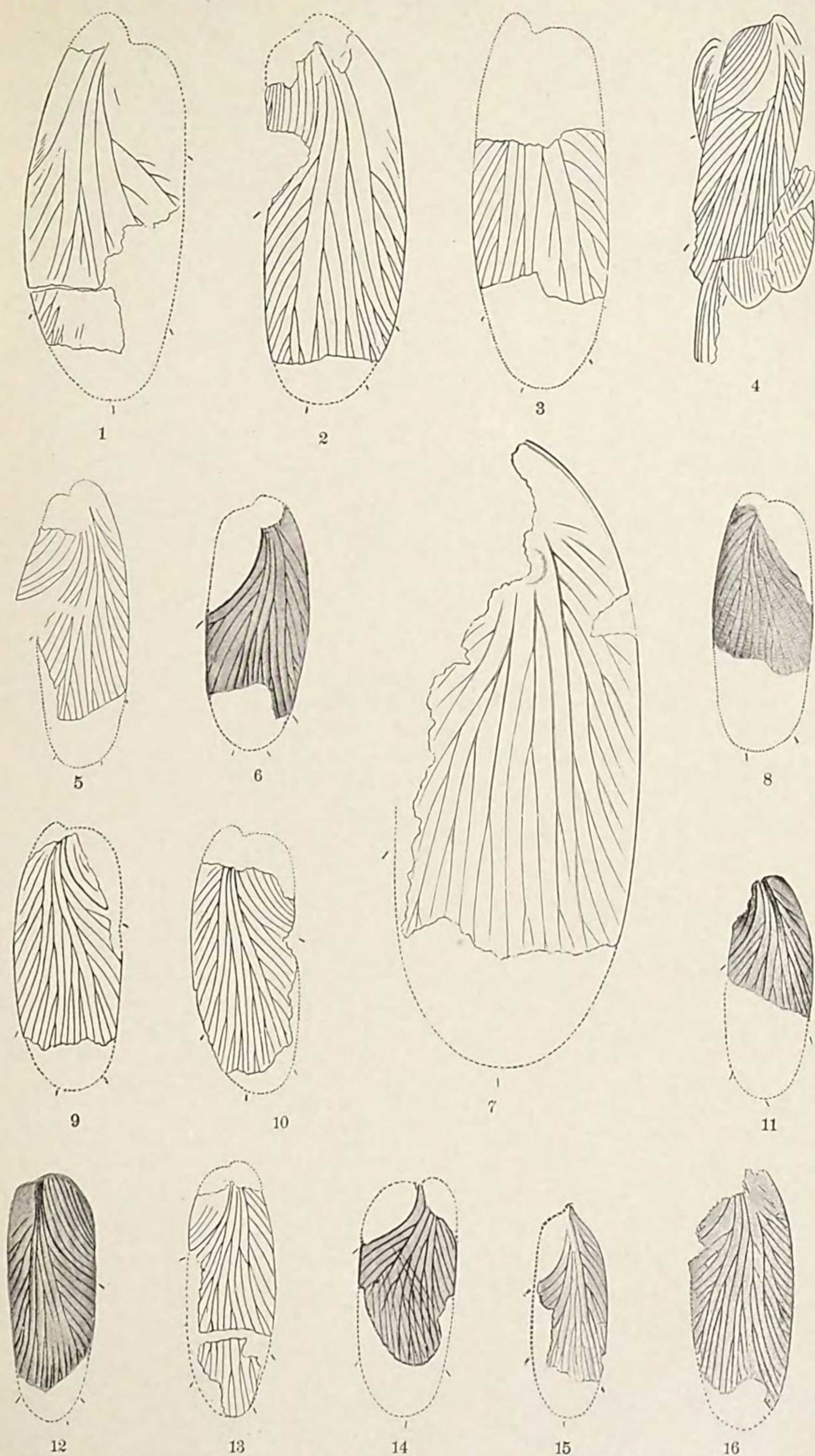
PLATE X.

EXPLANATION OF PLATE X.

All the drawings are by J. Henry Blake, excepting figs. 3 and 5 by S. H. Scudder, and fig. 8 by Katherine Peirson Ramsay. All are magnified two diameters.

Fig. 1. *Gerablattina richmondiana* (169). Richmond, Ohio.

2. *Gerablattina cassvici* (2142*a*). Cassville, W. Va.
3. *Gerablattina cassvici* (2142*c*). Cassville, W. Va.
4. *Gerablattina concinna* (2077*a*). Cassville, W. Va.
5. *Gerablattina concinna* (2077*c*). Cassville, W. Va.
6. *Gerablattina abdicata* (2143). Cassville, W. Va.
7. *Gerablattina scapularis*. Pawtucket, R. I.
8. *Gerablattina uniformis* (2082*f*). Cassville, W. Va.
9. *Gerablattina uniformis* (2082*a*). Cassville, W. Va.
0. *Gerablattina uniformis* (2082*c*). Cassville, W. Va.
11. *Gerablattina uniformis* (2082*e*). Cassville, W. Va.
12. *Gerablattina permanenta* (2144). Cassville, W. Va.
13. *Gerablattina permacra* (2188). Cassville, W. Va.
14. *Gerablattina eversa* (2145). Cassville, W. Va.
15. *Gerablattina deducta* (2146). Cassville, W. Va.
16. *Gerablattina fraterna*. East Providence, R. I.



BLATTINARIÆ: SPECIES OF GERABLATTINA.

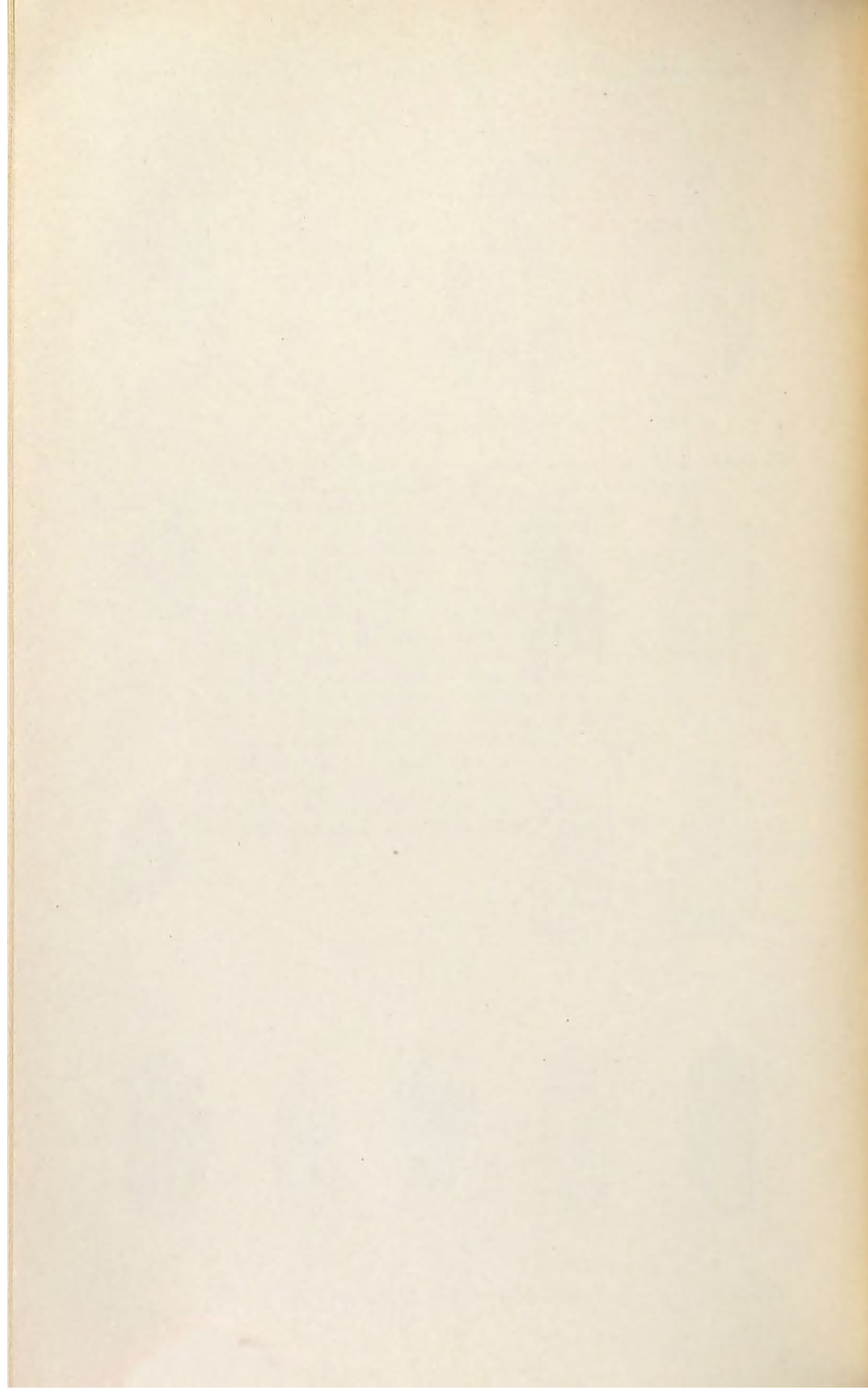
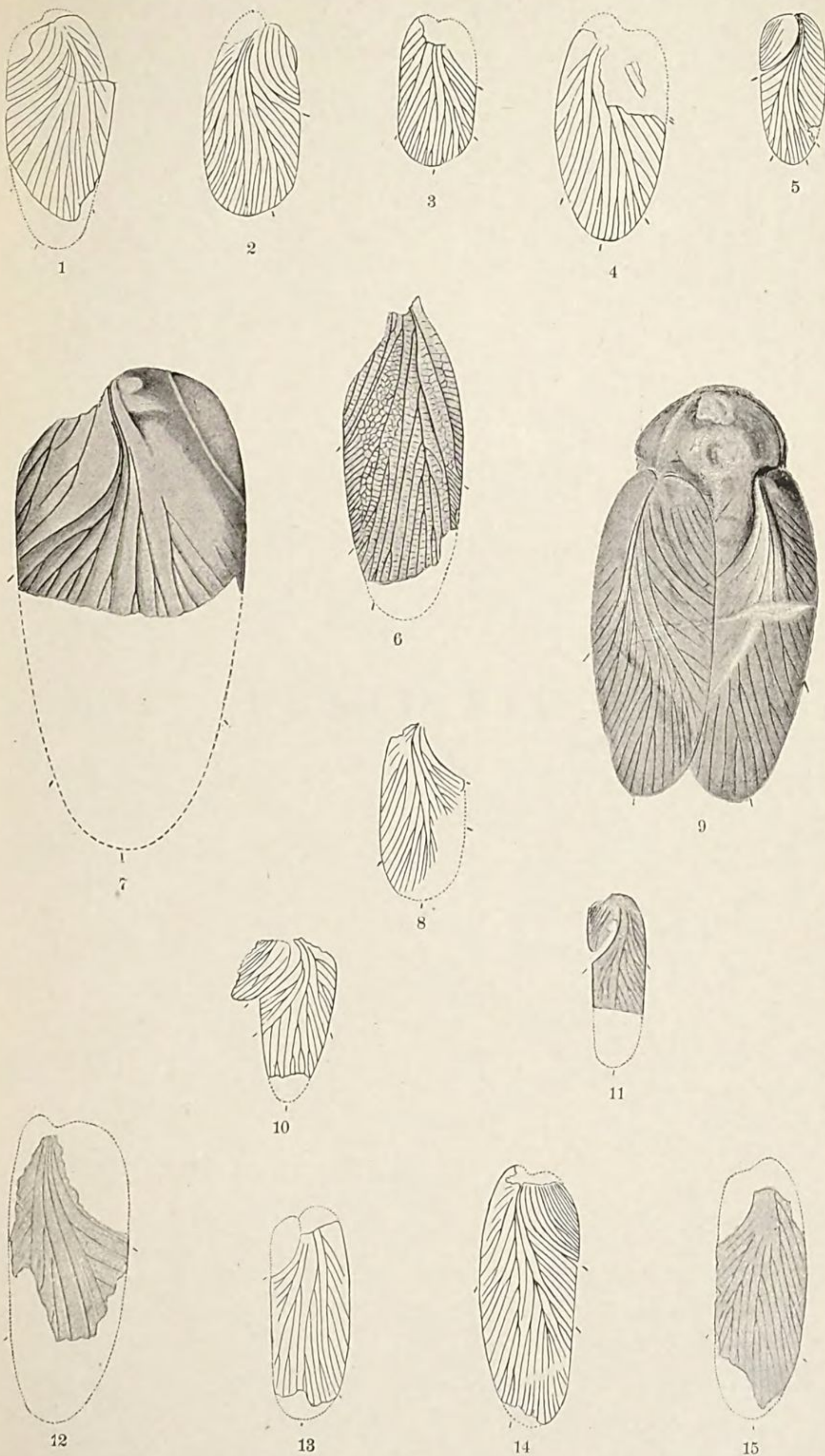


PLATE XI.

EXPLANATION OF PLATE XI.

All the drawings are by J. Henry Blake, excepting figs. 1 and 13 by S. H. Scudder, figs. 11 and 15 by Katherine Peirson Ramsay, and fig. 12 by J. H. Emerton. All are magnified two diameters.

- Fig. 1. *Gerablattina radiata* (2147). Cassville, W. Va.
2. *Gerablattina lata* (2148). Cassville, W. Va.
3. *Gerablattina rotundata* (2149). Cassville, W. Va.
4. *Gerablattina ovata* (2150). Cassville, W. Va.
5. *Gerablattina minima* (2183). Richmond, Ohio.
6. *Oryctoblattina laqueata* (2136). Kansas City, Mo.
7. *Anthracoblattina americana* (2137). Clinton, Mo.
8. *Anthracoblattina virginensis* (2138). Cassville, W. Va.
9. *Progonoblattina columbiana*. Mazon Creek, Illinois.
10. *Petrablattina hastata* (2133). Cassville, W. Va.
11. *Poroblattina ohioensis* (162). Richmond, Ohio.
12. *Poroblattina longinqua* (111). Richmond, Ohio.
13. *Poroblattina gratiosa* (2134). Cassville, W. Va.
14. *Poroblattina complexinervis* (2135). Cassville, W. Va.
15. *Poroblattina fossa* (2083). Cassville, W. Va.



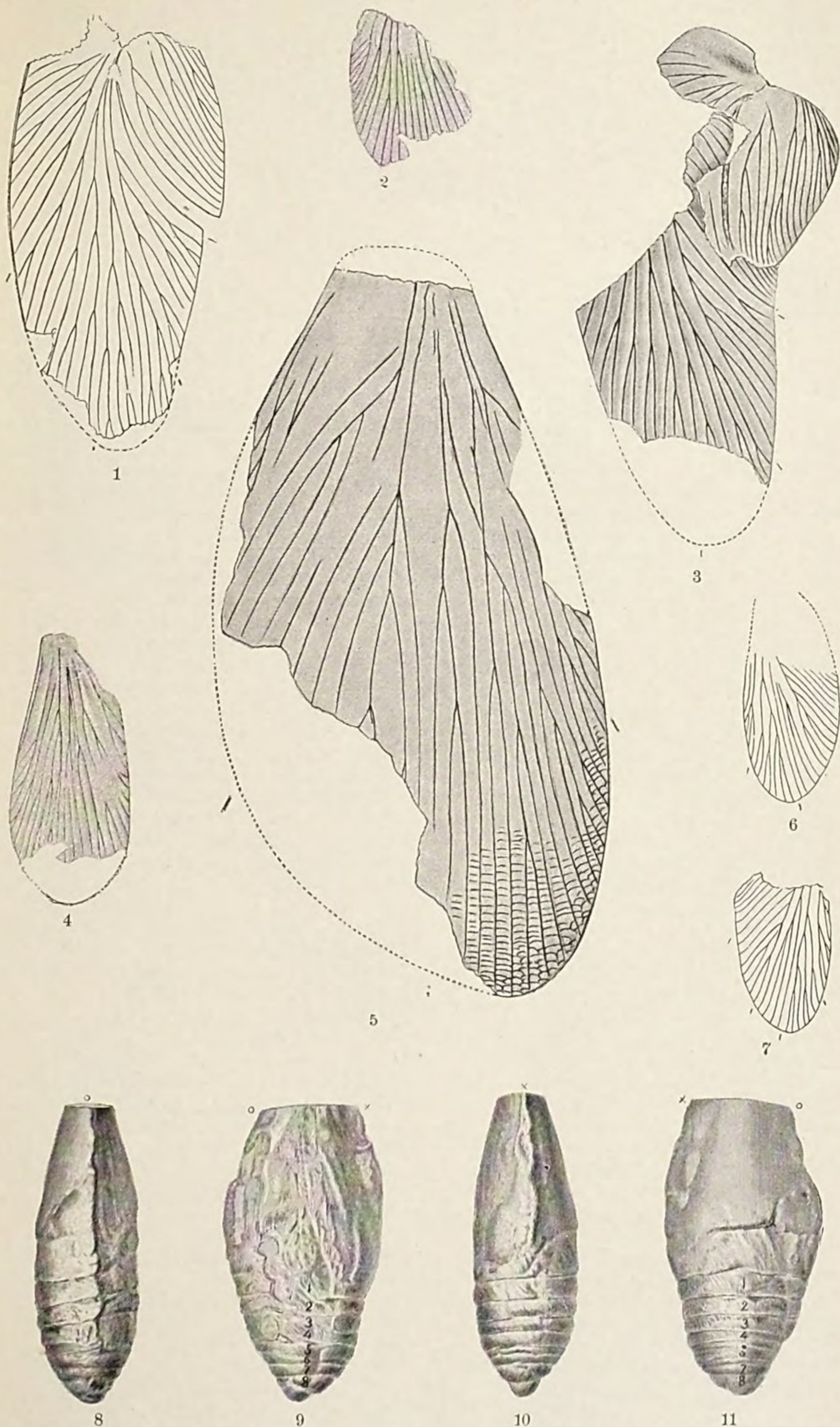
BLATTINARIÆ: SPECIES OF GERABLATTINA, ORYCTOBLATTINA, ANTHRACOBLATTINA, PROGONOBLATTINA, PETRABLATTINA, AND POROBLATTINA.

PLATE XII.

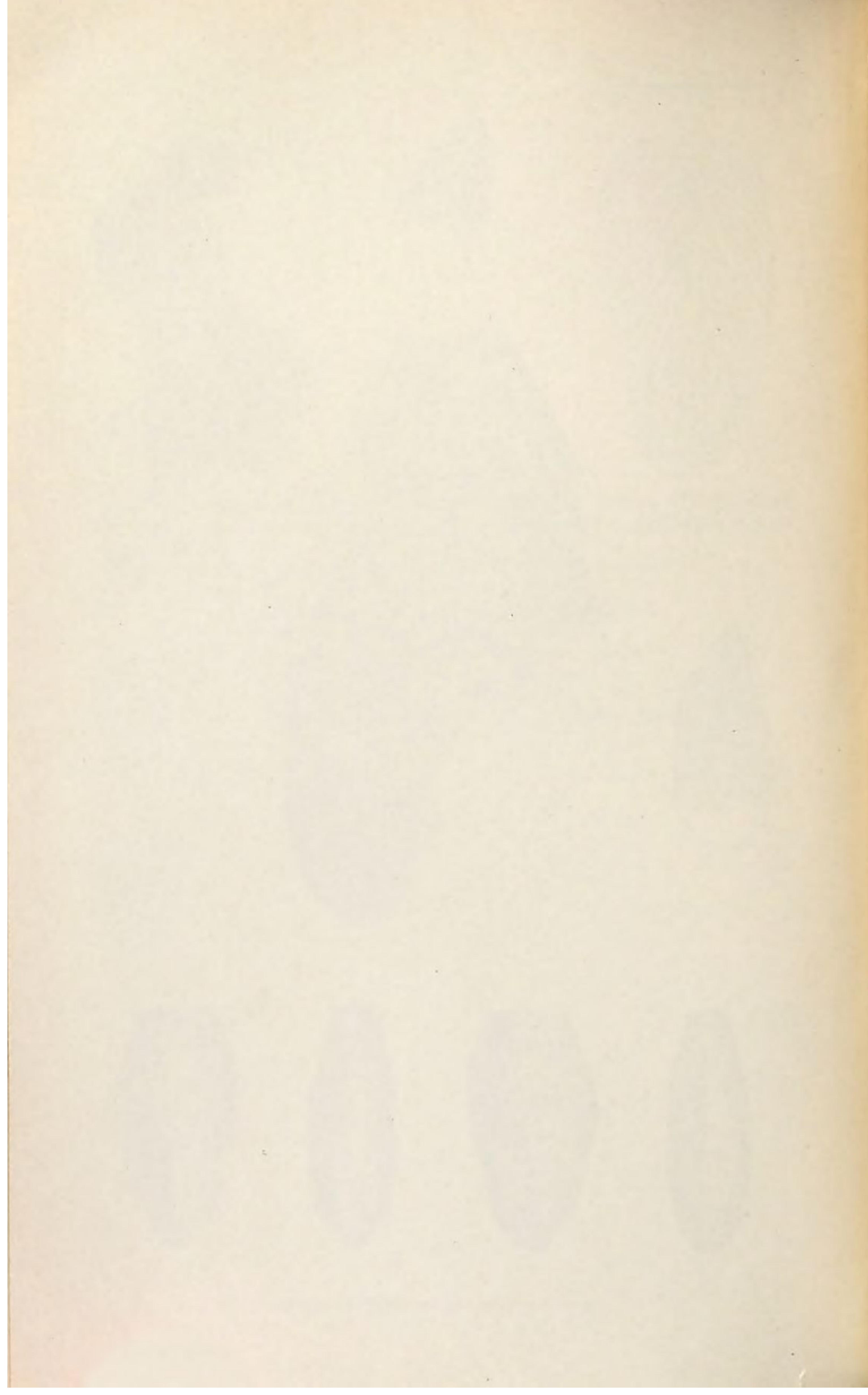
EXPLANATION OF PLATE XII.

All the drawings are by J. Henry Blake, excepting fig. 5 which is by Katherine Peirson Ramsay. All are magnified two diameters, excepting figs. 8-11 which are of natural size.

- Fig. 1. *Etoblattina deanensis* (2132*b*). Forest of Dean, England.
2. *Etoblattina* sp. East Providence, R. I.
3. *Etoblattina deanensis* (2132*c*). Forest of Dean, England.
4. *Etoblattina* sp.; hind wing. Cranston, R. I.
5. *Blattina* sp.; hind wing (2038). Mazon Creek, Illinois.
6. *Etoblattina* sp.; hind wing (2084*a*). Cassville, W. Va.
7. *Etoblattina* sp.; hind wing (2084*b*). Cassville, W. Va.
8. Body of cockroach; right-side view (4941). Illinois. (See p. 25.)
9. The same; ventral surface.
10. The same; left-side view.
11. The same; dorsal surface.



MISCELLANEOUS REMAINS OF COCKROACHES.



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CHARLES D. WALCOTT, DIRECTOR

THE
CONSTITUTION OF THE SILICATES

BY

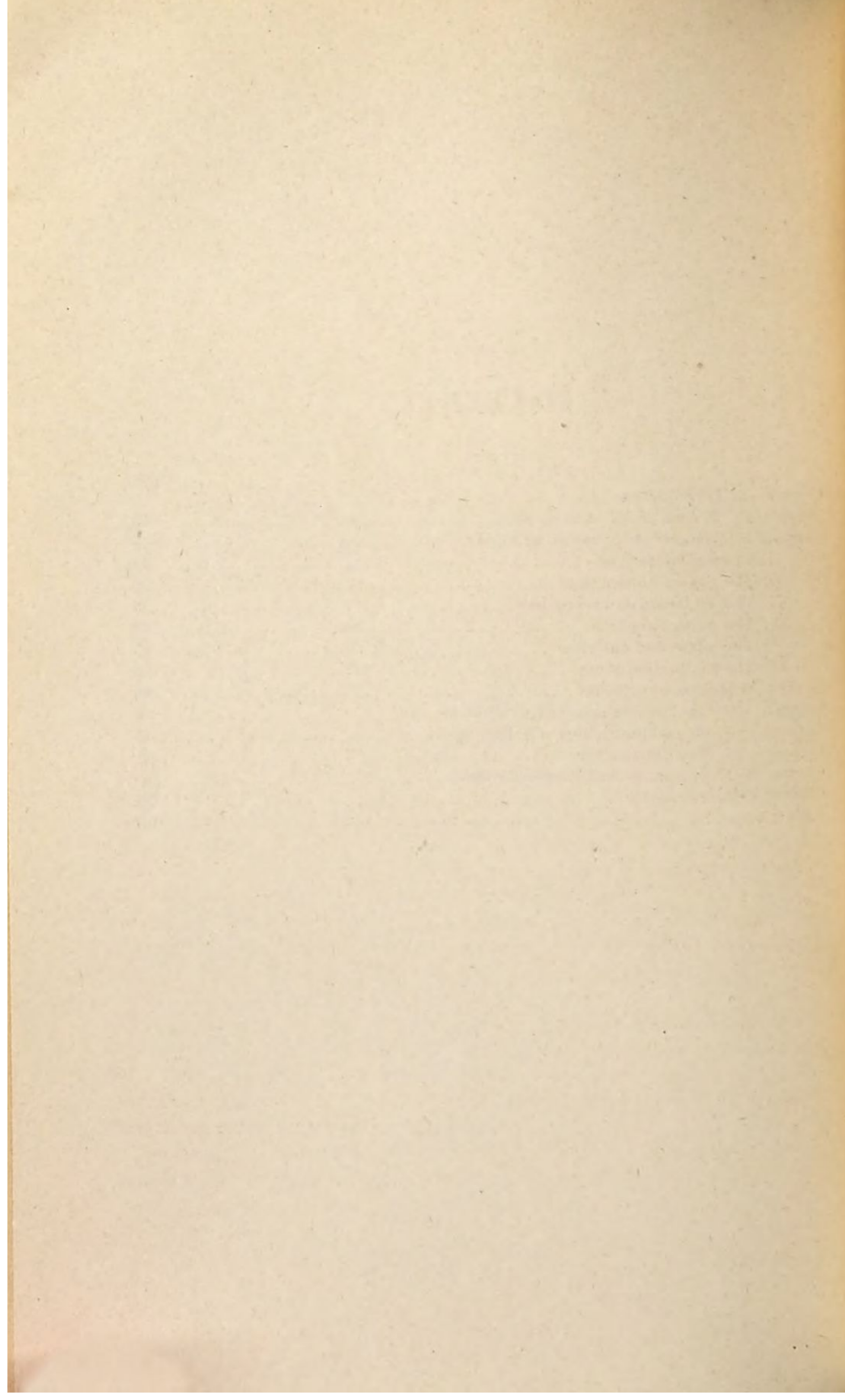
FRANK WIGGLESWORTH CLARKE
CHIEF CHEMIST



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THE CONSTITUTION OF THE SILICATES.

BY F. W. CLARKE.

CHAPTER I.

INTRODUCTION.

In the solid crust of the earth the silicates are by far the most important constituents. They form at least nine-tenths of the entire known mass, and comprise practically all of the rocks except the sandstones, quartzites, and carbonates; even these exceptions are commonly derivatives of the silicates, which break up under various conditions, yielding simpler bodies of their own class, together with free silica and limestone. From a geological point of view, therefore, the silicates are of fundamental importance, and a study of their inner constitution may be reasonably expected to shed light upon many serious problems. For example, every primitive rock or eruptive mass contains an aggregation of silicates, each one of which is capable of undergoing chemical change in accordance with limitations imposed by the structure of its molecules. When these changes take place, secondary compounds, alteration products, are formed, and in time the rock becomes transformed into new substances, quite unlike those which originally existed. A knowledge of the processes which thus occur should be applicable to the study of the rocks, and should ultimately render it possible so to investigate a metamorphosed mass as to clearly indicate its origin. These processes are dependent upon chemical structure, and the study of this with regard to the silicates is the purpose of the present memoir.

From the standpoint of the chemist the problem under consideration is one of great importance, but also of great difficulty. Some of the difficulty is real, some only apparent. At first sight the natural silicates appear to be compounds of great complexity; but this difficulty becomes much less serious after careful examination. Few of the natural silicates exist in even an approximately pure condition; many that seem fresh have undergone traces of alteration; isomorphous mixtures are exceedingly common; and much confusion is due to defective analyses. By multiplied observations these difficulties can be eliminated from the problem, but others yet remain to be disposed of. The organic chemist, to whom most of our knowledge of chemical structure

is due, deals mainly with bodies of known molecular weight, which can be measured by the density of a vapor or by cryoscopic methods. To the mineral chemist such knowledge is not available, for the compounds which interest him are neither volatile nor soluble, and their molecular weights can only be inferred. The simplest empirical formula of a silicate is not necessarily its true formula; the latter may be a multiple or polymer of the former; and here we find a difficulty which is at present almost insuperable. Strong evidence can be brought to bear upon this side of the question, but it is only partial evidence and not finally conclusive. The case, however, is by no means hopeless, for even the partial solution of a problem is better than no solution at all. An approximation is some gain, and it is possible so to investigate the constitution of the silicates as to bring many relations to light, developing formulæ which express those relations and indicate profitable lines for future research.

The problem is open to attack from several points of view, and various methods of investigation can be brought to bear upon it. First, of course, the empirical formula of each silicate must be definitely ascertained, which involves the discussion of sufficiently numerous analyses and the elimination of possible errors due to impurity, alteration, and isomorphous admixtures. In this work the microscope renders important service to the analyst, and makes his results much more certain. By the aid of the microscope many supposed mineral species have been proved to be mixtures, and the problem of the silicates has been thereby simplified. Indeed, the final outcome of such investigation generally indicates, for any given natural silicate, simplicity of composition; and this is what should be expected. These compounds are, as a rule, exceedingly stable salts, while complex substances are commonly characterized by instability. The mineral silicates are formed in nature under conditions of high temperature or are deposited from solutions in which many reactions are simultaneously possible, and these circumstances are strongly opposed to any great complications of structure. Furthermore, they are quite limited in number, only a few hundred at most being known; whereas, if complexity were the rule among them, slight variations in origin should produce corresponding variations in character, and millions of different minerals would be generated. That few variations exist is presumptive evidence that only few are possible, and hence simplicity of constitution is reasonably to be inferred. In fact, we find the same small range of mineral species occurring under the same associations in thousands of widely separated localities; a few typical forms containing a few of the commonest metals being almost universally distributed. The longer the evidence is considered, the stronger the argument in favor of simple silicate structures becomes.

Having established the empirical formula of a silicate, its physical properties may next be considered; and of these the crystalline form

and the specific gravity are the most important. From identity of form, or complete isomorphism between two species, we infer similarity of chemical structure, and the inferences thus drawn are often of the highest value. On the other hand, dissimilarity of form and identity of composition indicate isomerism, as for example in the cases of andalusite and kyanite; and here again we secure evidence which bears directly upon the study of chemical constitution. From the specific gravity the so-called molecular volume of a species may be computed, and that datum gives suggestions as to the relative condensation of a molecule in comparison with others of similar empirical composition. For instance, leucite and jadeite are empirically of similar type; but the latter has by far the greater density, together with superior hardness. It is, therefore, presumably more complex than leucite, and this supposition must be taken into account in considering its ultimate formula.

From what may be called the natural history of a mineral, still another group of data can be drawn, relating to its genesis, its constant associations, and its alterability. In this connection pseudomorphs become of the utmost interest, and, properly studied, shed much light upon otherwise obscure problems. An alteration product is the record of a chemical change, and as such has weighty significance. The decomposition of spodumene into eucryptite and albite, the transformation of topaz into mica, and many like occurrences in nature, are full of meaning with reference to the problem now under consideration. Just here, however, great caution is necessary. Mineralogical literature is full of faulty records regarding alterations, and many diagnoses need to be revised. Pseudomorphs have been named by guesses, based upon their external appearance, and often a compact mica has been called steatite or serpentine. In every case an alteration product should be identified with extreme care, both by chemical and by microscopical methods; for without such precautions there is serious danger of error. In each instance the supposed fact must be scrupulously verified.

Closely allied to the study of natural alterations is their artificial production in the laboratory. The transformation of leucite into analcite, and of analcite back into leucite, is a case in point, and the admirable researches of Lemberg furnish many other examples. Work of this character is much less difficult than was formerly supposed, and its analogy to the methods of organic chemistry renders its results highly significant. Atoms, or groups of atoms, may be split off from a molecule and replaced by others, and the information so gained bears directly upon the question of chemical structure. With evidence of this sort relations appear which could not otherwise be recognized, and these relations may be closely correlated with observations of natural occurrences.

Evidence of the same or similar character is also furnished by the

thermal decomposition of silicates, a line of investigation which has been successfully followed by several investigators. Thus garnet, when fused, yields anorthite and an olivine; natrolite gives nepheline; talc, upon ignition, liberates silica; and the prolonged heating of ripidolite produces an insoluble residue having the empirical composition of spinel. All of these facts have relevancy to the problem of chemical constitution, and their number could easily be enlarged by experiment. As yet the field has been barely scratched upon the surface; upon deeper cultivation a goodly crop may be secured.

The artificial synthesis of mineral species, with the allied study of crystalline slags and furnace products, furnishes still more evidence of pertinent utility. But, here again, caution is needed in the interpretation of results. A compound may be produced in various ways, and it does not follow that the first method which is successful in the laboratory is the method pursued by nature in the depths of the earth. The data yielded by synthesis are undoubtedly helpful in the determination of chemical constitution, but they furnish only a small part of the proof needed for complete demonstration, and their applicability to geological questions is limited in the extreme. For the latter purpose they are only suggestive, not final.

Suppose now that the empirical formula of a silicate has been accurately fixed, and that a mass of data such as I have indicated are available for combination with it. Suppose the physical properties to be determined, the natural relations known, the alteration products observed, its chemical reactions and the results of fusion ascertained; what then? It still remains to combine these varied data into one expression which shall symbolize them all, and that expression will be a constitutional formula. To develop this, the established principles of chemistry must be intelligently applied, with due regard to recognized analogies. The grouping of the atoms must be in accord with other chemical knowledge; they must represent known or probable silicic acids; and any scheme which fails to take the latter consideration into account is inadmissible. Not merely composition, but function also is to be represented, and the atomic linking which leaves that disregarded may be beautiful to see, but is scientifically worthless. A good formula indicates the convergence of knowledge; if it fulfills that purpose it is useful, even though it may be supplanted at some later day by an expression of still greater generality. Every formula should be a means toward this end, and the question whether it is assuredly final is of minor import. Indeed, there is no formula in chemistry to-day of which we can be sure that the last word has been spoken.

In the development of constitutional formulæ for the silicates it sometimes happens that alternatives offer between which it is difficult to decide. Two or more distinct expressions may be possible, with the evidence for each so strong that neither can be accepted or abandoned. In such cases nothing can be done but to state the facts and await the

discovery of new data, to which, however, the formulæ themselves may give clues. This sort of uncertainty is peculiarly common among the hydrous silicates, and often arises from the difficulty of discriminating between water of crystallization, so called, and constitutional hydroxyl. If in every silicate analysis the state of hydration were carefully examined, the conditions of dehydration being observed at different temperatures, much of this obscurity would be avoided.

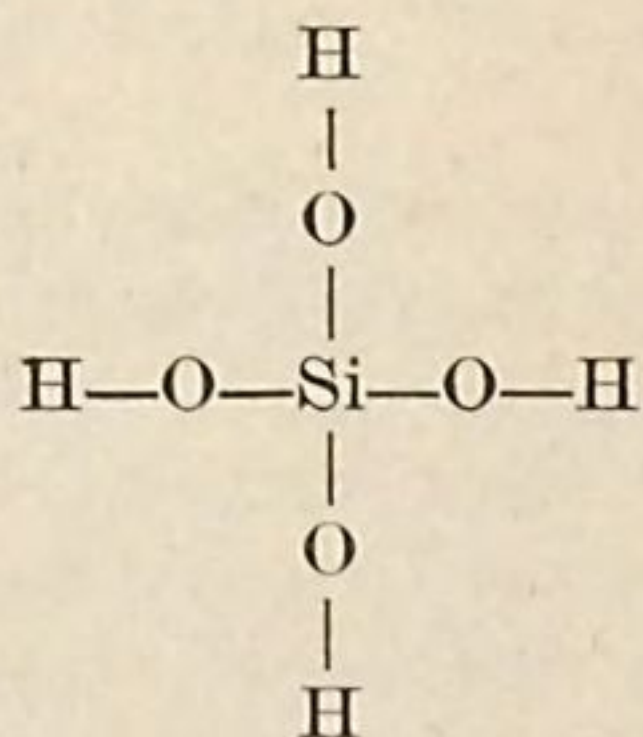
In discriminating between rival formulæ, one rule is provisionally admissible. Other things being equal, a symmetrical formula is more probable than one which is unsymmetrical. Symmetry in a molecule conduces to stability; most of the silicates are exceedingly stable; and hence symmetry is to be expected. This rule has presumptive value only, as an aid to judgment, and can not be held rigidly. It expresses a probability, but gives no proof. In a problem like that of the silicates, however, even a suggestion of this kind may render legitimate assistance.

CHAPTER II.

THE THEORY OF THE SILICATES.

If all of the silicates were salts of a single silicic acid, the problem of their constitution would be relatively simple; but this is not the case. Many silicic acids are theoretically possible, and several of them have representatives in the mineral kingdom, although the acids themselves, as such, are not known. Their nature must be inferred from their salts, and especially from their ethers, and this side of the problem is the first to be considered.

Since silicon is quadrivalent, its ortho acid is necessarily represented by one atom of the element united with four hydroxyl groups, thus— $\text{Si}(\text{OH})_4$, or, structurally:

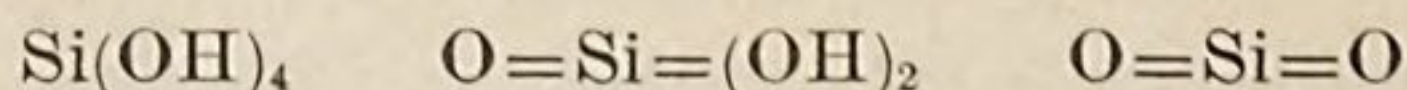


To this acid, orthosilicic acid, the normal silicic ethers and many common minerals correspond. Its normal salts, reduced to their simplest expressions, may be typically represented as follows:

<i>Types.</i>	<i>Examples.</i>
$\text{R}^{\text{i}}_4\text{SiO}_4$	$(\text{C}_2\text{H}_5)_4\text{SiO}_4$
$\text{R}^{\text{ii}}_2\text{SiO}_4$	Mg_2SiO_4
$\text{R}^{\text{iii}}_4(\text{SiO}_4)_3$	$\text{Al}_4(\text{SiO}_4)_3$
$\text{R}^{\text{iv}}\text{SiO}_4$	ZrSiO_4

Any silicate in which the oxygen atoms outnumber the silicon atoms by more than four to one, as for example the compound Al_2SiO_5 , must be regarded as a basic salt.

By elimination of water orthosilicic acid may be conceived as yielding, first, metasilicic acid, H_2SiO_3 , and, secondly, the anhydride, SiO_2 , thus:

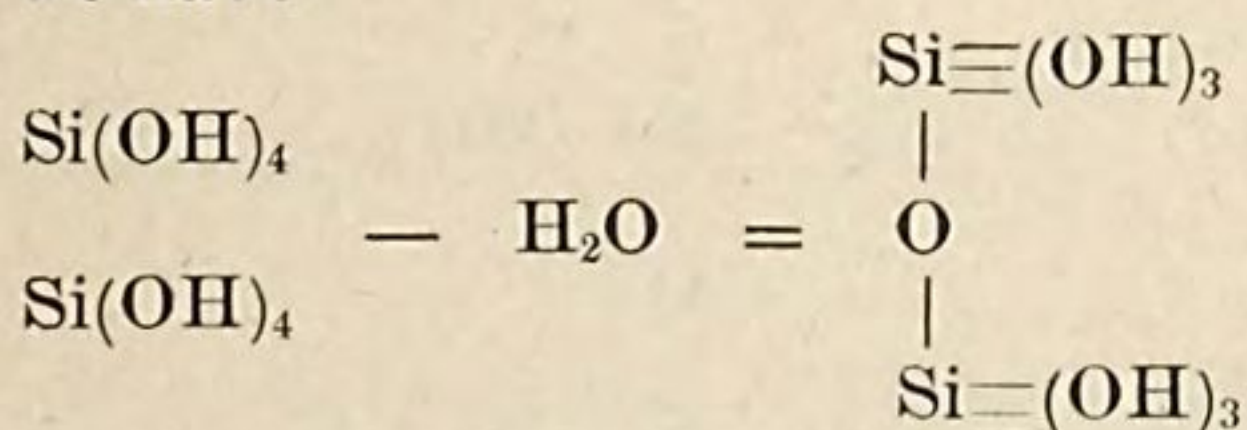


Corresponding to metasilicic acid many salts are known, but as yet no ethers have been certainly obtained. The ethers first described by Ebelmen were supposed to be metasilicates, but all recent investiga-

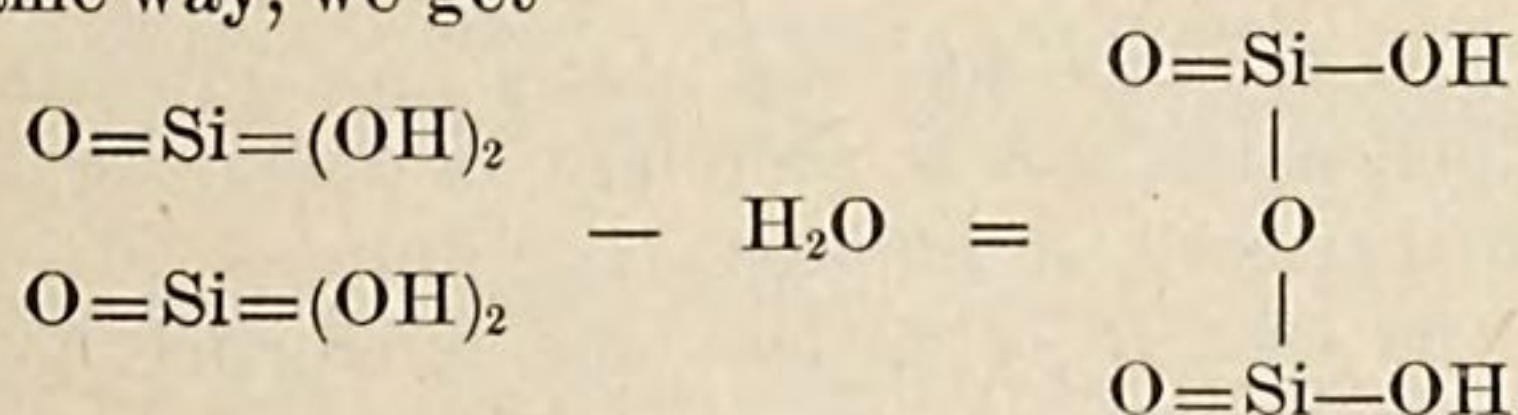
tions have shown them to be ortho compounds, possibly more or less impure. Troost and Hautefeuille, however, have described an ether having the formula, $(C_2H_5)_8Si_4O_{12}$, which is a polymer of a metasilicate; but its true nature has not been determined. The simplest formulæ for typical metasilicates are as follows:

<i>Types.</i>	<i>Examples.</i>
$R^I_2SiO_3$	Na_2SiO_3
$R^{II}SiO_3$	$MgSiO_3$
$R^{III}_2(SiO_3)_3$	$Al_2(SiO_3)_3^*$
$R^{IV}(SiO_3)_2$	$Zr(SiO_3)_2^*$

By eliminating a molecule of water from two molecules of orthosilicic or metasilicic acid, a disilicic acid may be produced. From orthosilicic acid we have



or, $H_6Si_2O_7$; a sexbasic acid of which several ethers have been obtained. It is, therefore, a well-established acid, and a number of silicates appear to be salts of it. It may be called diorthosilicic acid. From metasilicic acid, in the same way, we get

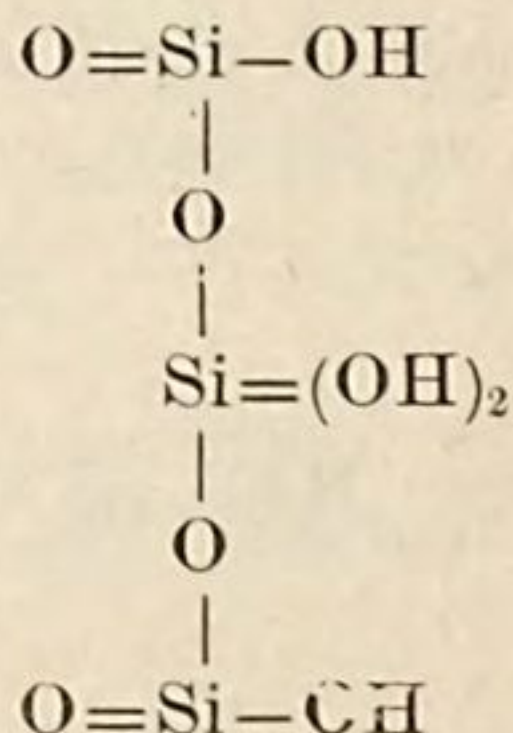


or dimetasilicic acid, $H_2Si_2O_5$. No ethers of this acid are known, but among its salts are the minerals petalite, milarite, ptilolite, and mordenite.

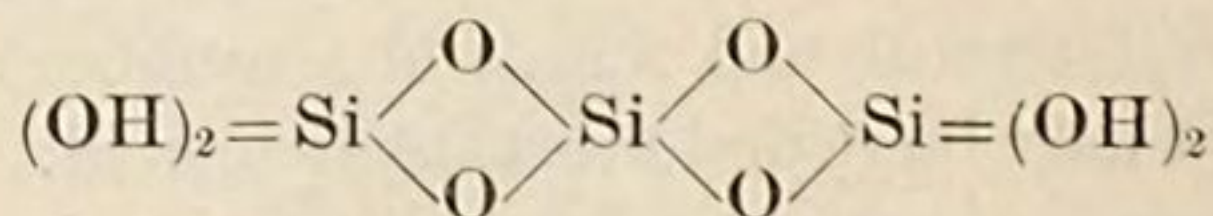
By a similar process, that is, the elimination of water from three or four molecules of orthosilicic acid, a series of tri- and tetrasilicic acids may be theoretically developed. These higher acids would present many possibilities for isomerism, and with their long chains of atoms would presumably be unstable. At all events, with a single exception, it is unnecessary to consider them in order to account for the natural silicates. The one exception is the tetrabasic acid $H_4Si_3O_8$, which appears most notably in eudidymite, the feldspars, the micas, and the scapolite group. The feldspars of this type, however, albite and orthoclase, are represented by Groth as mixed salts of two other silicic acids, when $Si_2O_5 + SiO_3 = Si_3O_8$; so that the trisilicic acid in question can be left out of consideration. But a general view of the whole field seems to point to its existence; at least greater simplicity is secured by retaining it in the scheme of silicic acids; and that policy

* Salts not actually known, but theoretically possible.

will be followed throughout this memoir. As opposed to Groth's view, we have also to consider the theory of Becker* that metasilicates may be really mixtures or compounds of ortho- and trisilicates, with $\text{H}_4\text{SiO}_4 + \text{H}_4\text{Si}_3\text{O}_8 = 4\text{H}_2\text{SiO}_3$. This theory may easily be pushed to an extreme, for the weight of evidence shows that true metasilicates exist; but in many cases it has real significance; that is, mixed salts are known having pseudometasilicate ratios, and these are most simply explained by Becker's theory, which, in the case of the micas, had been independently developed by myself. As to the constitution of trisilicic acid, we have no positive evidence, and at least two independent structures are conceivable, thus:



and



The first of these formulæ has the closer analogy with the formulæ of the other silicic acids, and is, therefore, in default of evidence, to be preferred. Furthermore, it indicates possibilities of isomerism, such as we find in the case of orthoclase and microcline, a consideration which is well worth bearing in mind.

So far, then, there are five silicic acids whose salts occur in the crust of the earth. They are:

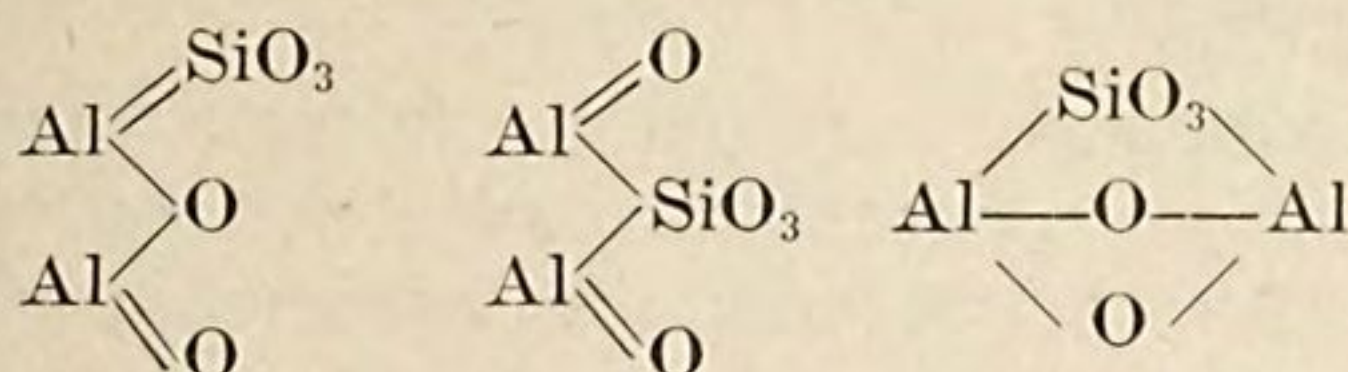
Orthosilicic acid	H_4SiO_4
Metasilicic acid	H_2SiO_3
Diorthosilicic acid	$\text{H}_6\text{Si}_2\text{O}_7$
Dimetasilicic acid	$\text{H}_2\text{Si}_2\text{O}_5$
Trisilicic acid	$\text{H}_4\text{Si}_3\text{O}_8$

and unless we admit the possible polymerization of metasilicic acid, as suggested by Troost and Hautefeuille's ether, no others need be invoked in order to account for the facts which are now available. The possibility of other silicic acids is an entirely distinct question.

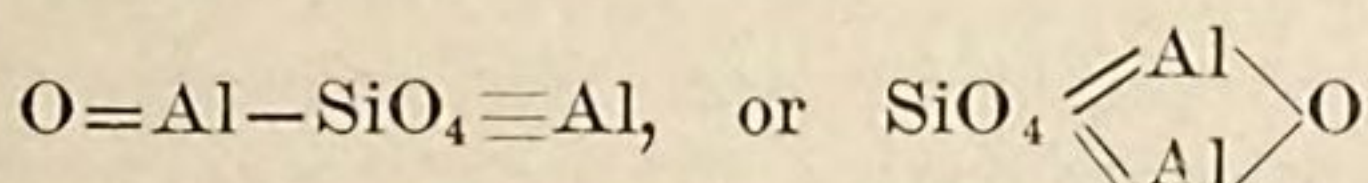
If the natural silicates were simple normal salts of the five silicic acids the problem of their constitution would not be difficult. But relatively few of the known species are of this description; the greater number are double salts, and even triple replacements are not uncommon. Furthermore, there are acid and basic salts to be interpreted,

* Am. Jour. Sci., (3) XXXVIII, p. 154, 1889.

and the latter class offers the most serious difficulties. A basic metasilicate, for example, may have the same empirical composition as an orthosilicate; so that its ratios, studied apart from other evidence, tell nothing as to the class in which it belongs. Take for instance the formula Al_2SiO_5 , which represents the composition of three distinct minerals, andalusite, sillimanite, and kyanite, and it admits of several different structural expressions. As a basic metasilicate it may be written



and as an orthosilicate it becomes either



If its molecular weight is a multiple of that indicated by the formula Al_2SiO_5 , then the possibilities of isomeric structure become still more complicated. Its composition alone does not give its molecular structure, and other evidence, as shown in the introduction to this memoir, must be brought to bear before the problem can be even approximately solved. This evidence is sometimes available, sometimes not, as will be seen in the systematic discussion of the individual species later.

A hasty glance over the entire field of the natural silicates will show, first, that many of them are most easily interpreted as orthosilicates, and, secondly, that by far the greater number are salts of aluminum. As regards both abundance and variety the aluminous silicates outrank all the others, and from the wide range of composition which they exhibit we can obtain clues to their constitution. In other words, they furnish the most evidence, and some of it is of the highest import. Their relations to one another are oftentimes clear and unmistakable, so that the constitution of one salt is the key to that of a second; and thus generalization becomes possible.

If we consider first the orthosilicates of aluminum, one general relation is easily made apparent. By a general relation I do not mean a universal relation, for exceptions are possible; but only that many of the salts are connected by a simple regularity, or even a law. To make this apparent it is necessary to recognize the fact that aluminum is now properly regarded as a trivalent metal, its formerly supposed quadrivalency being no longer admissible. Formulæ in which aluminum appears as a tetrad are not valid; and ferric iron, which replaces aluminum, follows the same rule. This point has been made clear by the vapor density and cryoscopic investigations of recent years, and is

sustained also by the position of aluminum in the periodic classification of the elements.

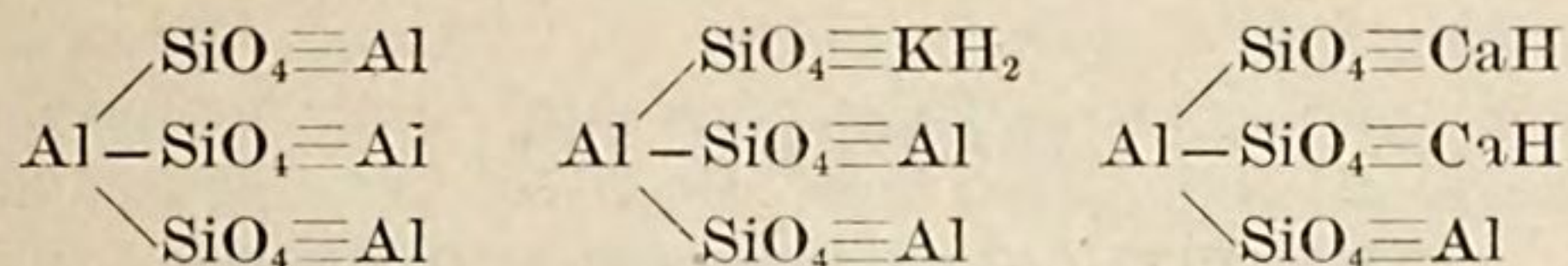
This much admitted, the general relation of which I have spoken is as follows: Many, perhaps all, of the orthosilicates of aluminum are most simply represented as substitution derivatives of the normal salt $\text{Al}_4(\text{SiO}_4)_3$. To illustrate this rule for present purposes, the following examples will suffice:

Aluminum orthosilicate	$\text{Al}_4(\text{SiO}_4)_3$
Eucryptite	$\text{Al}_3(\text{SiO}_4)_3\text{Li}_3$
Nephelite	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_3$
Kaliophilite	$\text{Al}_3(\text{SiO}_4)_3\text{K}_3$
Muscovite	$\text{Al}_3(\text{SiO}_4)_3\text{KH}_2$
Paragonite	$\text{Al}_3(\text{SiO}_4)_3\text{NaH}_2$
Andalusite	$\text{Al}_3(\text{SiO}_4)_3(\text{AlO})_3$
Topaz	$\text{Al}_3(\text{SiO}_4)_3(\text{AlF}_2)_3$
Natrolite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_2\text{H}_4$
Biotite	$\text{Al}_2(\text{SiO}_4)_3\text{MgKH}$
Grossularite	$\text{Al}_2(\text{SiO}_4)_3\text{Ca}_3$
Prehnite	$\text{Al}_2(\text{SiO}_4)_3\text{Ca}_2\text{H}_2$
Phlogopite	$\text{Al}(\text{SiO}_4)_3\text{Mg}_3\text{KH}_2$

These formulæ express not only the composition of the minerals, but also many facts concerning their relations, such as their association, their alteration one into another, and so on. Thus, topaz and andalusite are crystallographically akin; both minerals, as well as others in the series, alter easily into muscovite, and these facts become intelligible in the light of the formulæ given. In the use of the formulæ, however, one possible misconception must be avoided. They express a relationship of constitution, but do not imply that Nature first generated the normal salt and then actually developed the other compounds from it. To emphasize this point an analogy may be drawn from organic chemistry. Alizarin, derived constitutionally from anthracene, was originally obtained from a glucoside contained in madder root. But nobody supposes that the madder plant took anthracene as a starting point from which to produce the dye. The constitutional or structural derivation is one thing; the natural origin is quite another.

Whether aluminum orthosilicate as such exists in nature is still a matter of doubt. The rare mineral xenolite has the composition $\text{Al}_4(\text{SiO}_4)_3$, but it needs further study before its integrity as a species can be fully recognized. At present the weight of evidence seems to be in its favor, but its occurrence is that of a secondary mineral. Among the products of primitive magmas it has not been observed. As regards its ultimate constitution or chemical structure, that question must also be left open. It can be written structurally in several ways; either with each aluminum atom linked with all the SiO_4 groups or with only one atom so connected. In a sense this problem is analo-

gous to that offered by the benzene ring, prism, or nucleus, a conception of which the utility is fully recognized, in spite of outstanding uncertainties. For practical purposes, that is, for the coordination of known facts, expressions like the following are sufficient:



These expressions indicate the observed replaceability of aluminum atoms by other atoms or groups, and have no ulterior significance. So long as their limitations are kept in mind they are useful, but beyond this it would be unreasonable to go. With prolonged discussion and more evidence we may get a deeper insight into the nature of the fundamental molecule; at present, speculation concerning it would be premature. The relations expressed are clear, no matter what others may be revealed in the future. As a working hypothesis, the conception of substitution from a normal salt may be applied to many non-aluminous silicates, as in the magnesian series, the silicates of quadrivalent metals, and so on. These points will be developed in subsequent chapters. In the systematic discussion I shall begin with the orthosilicates, starting with those of aluminum, for the reason that they show most clearly the evidence relative to structure. In a classification of the silicates the starting point would be different, but this is not a classification. The trisilicates will be considered with the orthosilicates, for reasons which are obvious. In the feldspar, zeolite, and mica groups the ortho- and trisilicates can not well be separated.

CHAPTER III.

THE ORTHOSILICATES OF ALUMINUM.

I. THE NEPHELITE TYPE.

If, in accordance with the ideas developed in the preceding chapter, we start out from the normal salt $\text{Al}_4(\text{SiO}_4)_3$, the first and simplest replacement possible is that of a single aluminum atom by three monads, giving a compound of the general formula $\text{Al}_3(\text{SiO}_4)_3\text{R}'_3$. This formula represents several well-known minerals, and I propose to designate it as the *nephelite type*. At first sight it seems to be reducible to the simpler expression $\text{R}'\text{AlSiO}_4$, but that expression, as will be seen later, does not indicate all the known relations of the group.

The first three representatives of this type are as follows:

Eucriptite.....	$\text{Al}_3(\text{SiO}_4)_3\text{Li}_3$
Nephelite	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_3$
Kaliophilite	$\text{Al}_3(\text{SiO}_4)_3\text{K}_3$

These species are all hexagonal, are nearly equal in density, and all gelatinize with hydrochloric acid. The second and typical member of the series has been made synthetically, and is then found to have the composition indicated by the formula. The natural nephelite, however, has a composition which is more exactly represented by the complex formula $\text{R}'_3\text{Al}_3\text{Si}_9\text{O}_{34}$, in which a little potassium appears among the components of R' , while there is an excess of silica over the amount required by theory. The potassium is doubtless due to an isomorphous admixture of kaliophilite, and the excess of silica can be explained by the presence of a salt isomeric with albite and having the composition $\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{Na}_3$. This replacement of SiO_4 by Si_3O_8 appears to be common among the silicates, and its recognition clears up many discrepancies. In this case one molecule of the trisilicate commingled with fifteen of the ortho-salt will produce the divergence from normal composition shown in the analyses of natural nephelite.

By direct alteration nephelite passes easily into two zeolitic minerals, having the subjoined formulæ:

Hydronephelite	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_2\text{H}.3\text{H}_2\text{O}$
Natrolite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_2\text{H}_4$

In natrolite, two atoms of aluminum have been replaced by $\text{R}'_6 = \text{Na}_2\text{H}_4$, and this species, with others of like origin, falls therefore into another group. Still it is desirable now to call attention to the fact,

observed by Doelter,* that natrolite on fusion yields nephelite. The connection between the two species is unmistakable.

Eucryptite and nephelite both alter with great ease into muscovite, a potassium salt of which paragonite is the sodium equivalent. Furthermore, C. and G. Friedel,† by heating finely divided muscovite to 500° in a solution of alkali, obtained nephelite in crystals. From this evidence the formulæ of muscovite and paragonite become directly related to those of the nephelite series, thus:

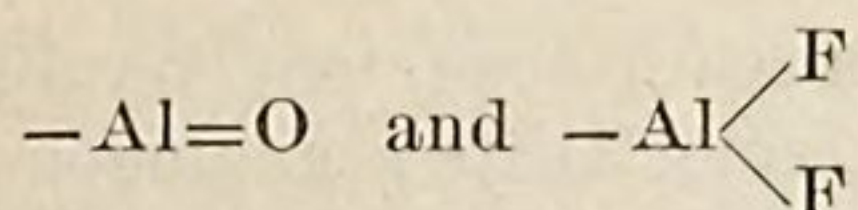
Nephelite.....	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_3$
Muscovite.....	$\text{Al}_3(\text{SiO}_4)_3\text{KH}_2$
Paragonite.....	$\text{Al}_3(\text{SiO}_4)_3\text{NaH}_2$

Physically, the two micas have no resemblance to nephelite, being different in form, slightly denser, and refractory toward acids. The relationship is purely one of chemical type, and is established by the fact of alteration from one into another.

Through muscovite a connection is recognizable between the foregoing species and the two minerals andalusite and topaz, whose simplest formulæ, tripled, may be written as follows:

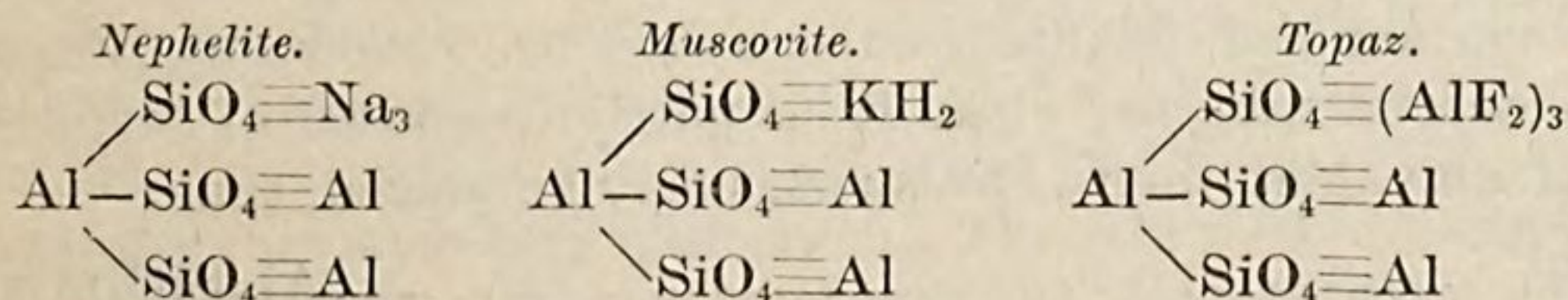
Topaz.....	$\text{Al}_3(\text{SiO}_4)_3(\text{AlF}_2)_3$
Andalusite.....	$\text{Al}_3(\text{SiO}_4)_3(\text{AlO})_3$

Here we encounter the evidently univalent atomic groups



both of which play an important part in various other minerals. The two species, topaz and andalusite, are closely allied crystallographically. They have sensibly identical molecular volumes, and both undergo alteration into muscovite mica. In topaz, as shown by the investigations of Penfield and of Jannasch, hydroxyl commonly replaces a part of the fluorine; hydroxyl and fluorine being clearly isomorphous. The formula given is that of normal topaz, entirely free from alteration.

To sum up, we have now eight definite species represented by the fundamental type $\text{Al}_3(\text{SiO}_4)_3\text{R}'_3$, the first substitution from the normal orthosilicate of aluminum. Leaving hydronephelite on one side, because of its water of crystallization, the remaining seven species fall into three subtypes, as follows:



symbols which clearly indicate the known chemical relations between the several minerals. In five of the eight examples the simplest pos-

* Allgem. Chem. Mineralogie, p. 183.

† Bull. Soc. Min., XIII, p. 129, 1890.

sible formulæ have been tripled, for otherwise the relationships which exist could not be structurally shown. The correctness of this procedure will appear still more definitely in the consideration of the groups which follow.

The species sillimanite is isomeric with andalusite, but the structural character of the isomerism is not clear. The minerals kornorupine and kryptotile, which will be considered later, are possibly also representatives of the nephelite type.

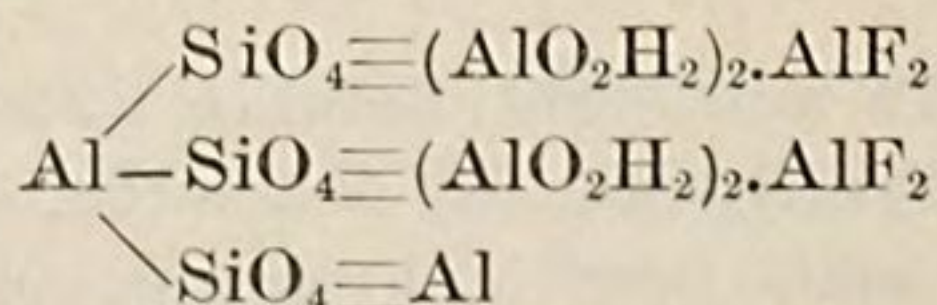
II. THE GARNET-BIOTITE TYPE.

By this title I propose to designate the second series of derivatives from the normal salt $\text{Al}_4(\text{SiO}_4)_3$, in which two atoms of aluminum have been replaced. The general formula of the type, obviously, is $\text{Al}_2(\text{SiO}_4)_3\text{R}'_6$, and in this series bivalent elements or radicles frequently appear. In natrolite, $\text{R}'_6 = \text{Na}_2\text{H}_4$; in biotite, $\text{R}'_6 = \text{R}''_2\text{R}'_2$; and in garnet R'_6 are entirely replaced by R''_3 . There are, therefore, three subtypes to consider; one in which all the replacing atoms are univalent, one in which all are bivalent, and one intermediate between the other two.

Under the first subtype three species seem definitely to occur, viz:

Natrolite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_2\text{H}_4$
Dumortierite	$\text{Al}_2(\text{SiO}_4)_3(\text{AlO})_6$
Zunyte	$\text{Al}_2(\text{SiO}_4)_3\text{R}'_6^*$

Natrolite, as we have already seen, may be directly derived from nephelite by alteration. Dumortierite is analogous to andalusite, and, like the latter, is orthorhombic. In zunyte R'_6 is composed of the groups $-\text{Al}=\text{F}_2$, $-\text{Al}=\text{Cl}_2$, and $-\text{Al}=(\text{OH})_2$, with possibly a little $-\text{Al}=\text{O}$, and the mineral thus seems to be chemically related to dumortierite in the same way that topaz is related to andalusite. But topaz and andalusite have crystallographic analogy, while zunyte, being isometric, is quite unlike its chemical congeners. The species evidently needs further study, but at present, if we unite the chlorine in it with the fluorine, it may be provisionally represented by the expression



This formula expresses the facts which are now available, but is not conclusive. Its isometric character, however, helps to connect zunyte with the garnet and sodalite groups, as has been shown by Brögger.†

In the second subtype, when R'_6 is partly composed of bivalent and partly of univalent atoms, two species may be placed, thus:

Prehnite	$\text{Al}_2(\text{SiO}_4)_3\text{Ca}_2\text{H}_2$
Biotite	$\text{Al}_2(\text{SiO}_4)_3\text{Mg}_2\text{HK}$

* Groth's formula, generalized.

† Zeit. Kryst. Min., XVIII, p. 209.

Possibly the tetragonal sarcolite, which has the general formula of a garnet with the lime partly replaced by soda, may fall here also; but the analyses of this mineral are unsatisfactory, and its relations are still uncertain. Biotite will be more fully considered in the special chapter devoted to the mica group. Prehnite, according to Doelter,* decomposes on fusion, yielding the same products as garnet.

Under the third subtype of this series we find the garnet group itself, together with epidote and several related species. The sodalite group is also akin to garnet and to the second subtype, and will be considered in this connection a little later. Under the generic term garnet several species are included, all being isometric and strictly isomorphous, in which magnesium, calcium, and ferrous iron replace one another, while chromium, aluminum, and ferric iron are also equivalent terms. Thus we have:

Grossularite	$\text{Al}_2(\text{SiO}_4)_3\text{Ca}_3$
Pyrope	$\text{Al}_2(\text{SiO}_4)_3\text{Mg}_3$
Almandite	$\text{Al}_2(\text{SiO}_4)_3\text{Fe}''_3$
Spessartite	$\text{Al}_2(\text{SiO}_4)_3\text{Mn}_3$
Andradite	$\text{Fe}_2(\text{SiO}_4)_3\text{Ca}_3$
Ouvarovite	$\text{Cr}_2(\text{SiO}_4)_3\text{Ca}_3$

To these may be added schorlomite, a garnet in which titanium occurs both as part of the acid, that is, with TiO_4 replacing SiO_4 , and also as Ti''' among the triad bases, equivalent to aluminum. The monoclinic partschinite, isomeric with spessartite, also falls into this group.

In the epidote group, at least four species appear, one, zoisite, being orthorhombic, while the other three are monoclinic. These species are characterized by the bivalent group of atoms $=\text{Al}-\text{OH}$, thus:

Zoisite	$\text{Al}_2(\text{SiO}_4)_3\text{Ca}_2(\text{AlOH})$
Epidote, <i>a</i>	{ $\text{Al}_2(\text{SiO}_4)_3\text{Ca}_2(\text{AlOH})$
Epidote, <i>b</i>	
Piedmontite	$(\text{AlMn})_2(\text{SiO}_4)_3\text{Ca}_2(\text{AlOH})$
Allanite	$(\text{AlCeFe})_2(\text{SiO}_4)_3(\text{CaFe})_2(\text{AlOH})$

or, in general, as compared with garnet,

Garnet	$\text{R}'''_2(\text{SiO}_4)_3\text{R}''_3$
Epidote	$\text{R}'''_2(\text{SiO}_4)_3\text{R}''_2(\text{R}''''\text{OH})$

The facts that garnet alters into epidote and that the two minerals are often associated give emphasis to the formulæ. For epidote, however, an alternative formula is possible, in which the hydroxyl is supposed to be united with calcium rather than with aluminum. But epidote is a peculiarly stable mineral, while the group $-\text{Ca}-\text{OH}$ would imply instability and easy alteration. The alternative formula, therefore, is improbable, although it would ally epidote more easily with anorthite, which is a product of its fusion.

* Allgem. Chem. Mineralogie, p. 183.

Although garnet, as a rule, is unattacked by acids, and epidote is only in part decomposable, both species are so broken up by strong ignition as to be readily acted upon by hydrochloric acid, with separation of gelatinous silica. According to Doelter and Hussak,* garnet yields upon fusion sometimes anorthite and an olivine; or meionite, augite, and olivine; or melilite and anorthite; and occasionally spinel. Epidote, says Doelter,† yields lime-augite and anorthite, and prehnite behaves like garnet. These facts indicate analogies between the several species named, but are not easy of complete interpretation. The different products observed may be due in part to a direct splitting up of the original insoluble mineral into soluble species like anorthite and a lime-olivine, and in part to secondary reactions taking place during the prolonged fusion and cooling of the resultant magma. In other words, two sets of phenomena are probably involved in the observations, and it is impossible at present to distinguish between them. The first set alone is immediately relevant to the constitutional question now before us.

In the four species sodalite, hâüynite, nosite, and lazurite we have a group of minerals which Brögger has classified as alkali garnets.‡ Like garnet, they are all isometric, and they are characterized by the presence of the bivalent groups $=\text{Al}-\text{Cl}$, $=\text{Al}-\text{SO}_4-\text{Na}$, and $=\text{Al}-\text{S}-\text{S}-\text{S}-\text{Na}$. There are also artificial products, ultramarines, in which the groups $=\text{Al}-\text{S}-\text{S}-\text{Na}$ and $=\text{Al}-\text{S}-\text{Na}$ appear. Adopting Brögger's formulæ, which are preferable to those formerly proposed by myself,§ these species may be written as follows:

Sodalite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4(\text{AlCl})$
Hâüynite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_2\text{Ca}(\text{AlSO}_4\text{Na})$
Nosite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4(\text{AlSO}_4\text{Na})$
Lazurite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4(\text{AlS}_3\text{Na})$

They fall, therefore, properly under the second subtype, but are considered at this point on account of their analogies with garnet.

Through these species, and especially through sodalite, a connection with several other minerals is established. Sodalite occurs in elæolite syenytes, and is evidently derived from nephelite, and like the latter it yields natrolite, hydronephelite, and muscovite by alteration. Furthermore, C. and G. Friedel,|| on heating powdered muscovite with soda solution and sodium chloride at a temperature of 500° , obtained sodalite artificially, although nephelite was probably first formed as an intermediary, and the two species were commingled in the product.

The two hexagonal species, cancrinite and microsommite, are also, like sodalite, undoubtedly derivatives of nephelite, but their formulæ are rather uncertain. Cancrinite approximates to the composition

* Allgem. Chem. Mineralogie, p. 182.

† Allgem. Chem. Mineralogie, p. 183.

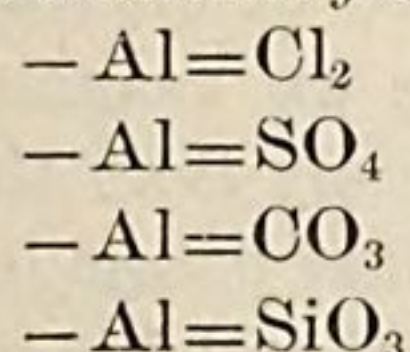
‡ Brögger and Bäckström, Zeit. Kryst. Min., XVIII, p. 209.

§ Bull. U. S. Geol. Survey No. 42, p. 38.

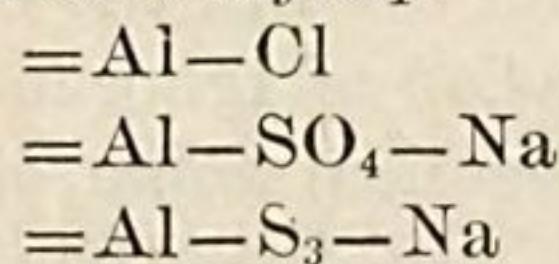
|| Bull. Soc. Min., XIII, p. 183.

$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4\text{H}(\text{AlCO}_3)$, in which a little soda is replaced by lime, and the univalent group $-\text{Al}=\text{CO}_3$ may be partly substituted by $-\text{Al}=\text{SiO}_3$. Microsommite, according to the published analyses, varies in composition widely, containing always potassium, and having a notable proportion of chlorine and sulphuric acid among its constituents. If, however, we assume in it the univalent radicles $-\text{Al}=\text{Cl}_2$ and $-\text{Al}=\text{SO}_4$, its composition reduces easily to the form $\text{Al}_2(\text{SiO}_4)_3(\text{NaK})_3\text{Ca}(\text{Al}(\text{SO}_4.\text{Cl}_2))$, like cancrinite, both species having then the composition of the general type $\text{Al}_2(\text{SiO}_4)_3\text{R}'_6$. The theory as proposed, then, assumes univalent complex radicles for cancrinite and microsommite, and bivalent radicles for the sodalite group, thus:

In cancrinite group.

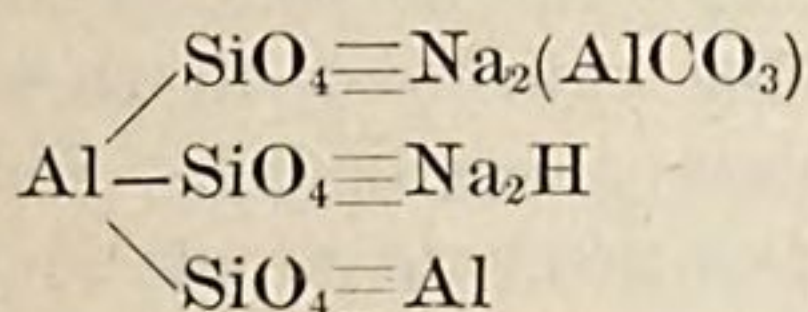


In sodalite group.

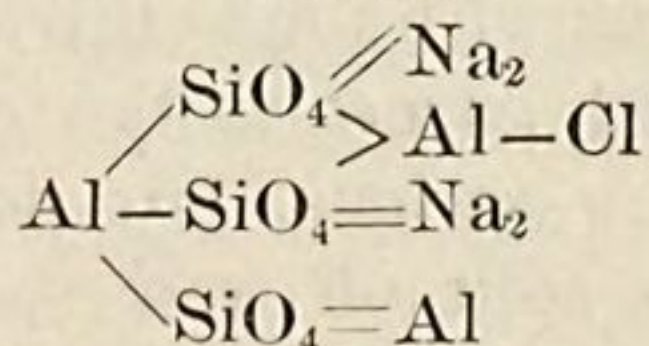


and the typical structures are as follows:

Cancrinite.



Sodalite.



Concerning these formulæ and the peculiar uni- and bivalent radicles assumed in them, there are arguments both for and against. The assumption of a group $-\text{Al}=\text{SiO}_3$, equivalent to and replacing $-\text{Al}=\text{CO}_3$, is clearly suggested by the experiments of Lemberg,* who, by the action of sodium silicate solution upon elæolite, obtained a compound which he designates as a cancrinite containing Na_2SiO_3 in place of Na_2CO_3 . By similar reactions with sodium carbonate he produced a substance having the composition of true cancrinite. Hence, whatever the ultimate molecular structure of cancrinite may be, we are amply justified in assuming in it the replaceability of CO_3 by SiO_3 .

These experiments fairly represent a large number of like kind which are due to Lemberg, and which may be found recorded in his various papers. Some of these will be cited later, but a reference to the work of his colaborer Thugutt† is in place at this point. Starting from a hydrated nephelite, artificially prepared from kaolin, Thugutt succeeded in producing a large series of compounds analogous to sodalite, in which the original silicate had taken up, at moderately high degrees of heat and pressure, various other salts of sodium, such as the chlorate, selenate, formate, oxalate, and so on. These compounds, however, are all hydrated, and so differ from the natural minerals of the sodalite group, and they are regarded by Thugutt as formed by molecular

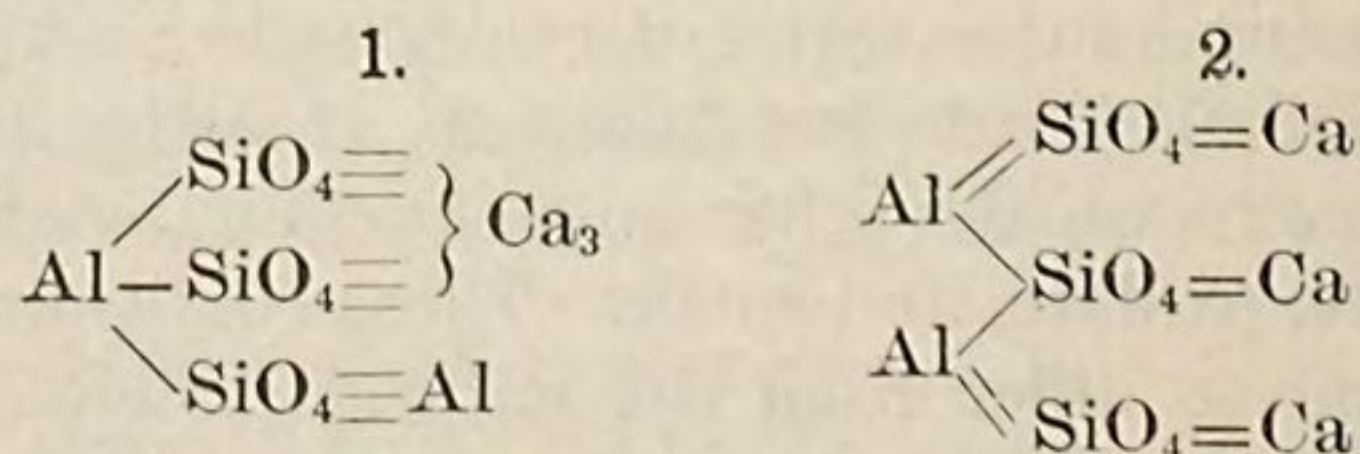
* Zetsch. Deutsch. Geolog. Gesell., 1885, p. 962.

† Mineralchemische Studien, Dorpat, 1891.

union. Following Lemberg, he regards sodalite as a molecular compound of nephelite with sodium chloride, and taking his series of compounds throughout, he looks upon the sodium salts which have been added to the fundamental silicate as equivalent in function to water of crystallization. In favor of this view he cites many arguments, some of which are entitled to considerable weight. Thus, when sodalite is ignited NaCl is driven off, whereas if the chlorine were united with aluminum AlCl_3 should be expelled. Similarly, by the action of water alone, sodium chloride can be split off from the sodalite molecule, thus indicating a looser form of union than the proposed structural formulæ show.

But what is molecular union? To this question there is no satisfactory answer, and even in the case of water of crystallization the term is only a confession of ignorance. Unless we assume the existence of two kinds of chemical union, it means merely that the structural linking is unknown, and that the problem is laid on one side, conveniently labeled for future reference. The constitutional formulæ here adopted for sodalite and cancrinite are intended to give a provisional solution of the problem in their particular cases, and to express the genetic relationships with nephelite on the one hand and the crystallographic analogy with garnet on the other. The objections to them raised by Thugutt are serious, but not absolutely conclusive. When sodium chloride is split off from sodalite the mechanism of the reaction is quite unknown, and the relative affinities in the molecule are quite unstudied. Until these are understood the objections raised by Lemberg, Thugutt, and others are not fatal. Furthermore, the presence of a group $=\text{Al}-\text{Cl}$ does not imply, as Thugutt supposes, the splitting off of AlCl_3 by heat. To effect such a decomposition three molecules of sodalite would have to be broken up, and there is no probability that such a disintegration could occur. At all events the formulæ proposed fulfill a definite purpose, even though they are not finally established. They express known relations, but not necessarily all the relations which the future may reveal. The facts that the sodalite-cancrinite minerals are derivable from nephelite, and that nephelite is again derivable from them, are unquestionable.

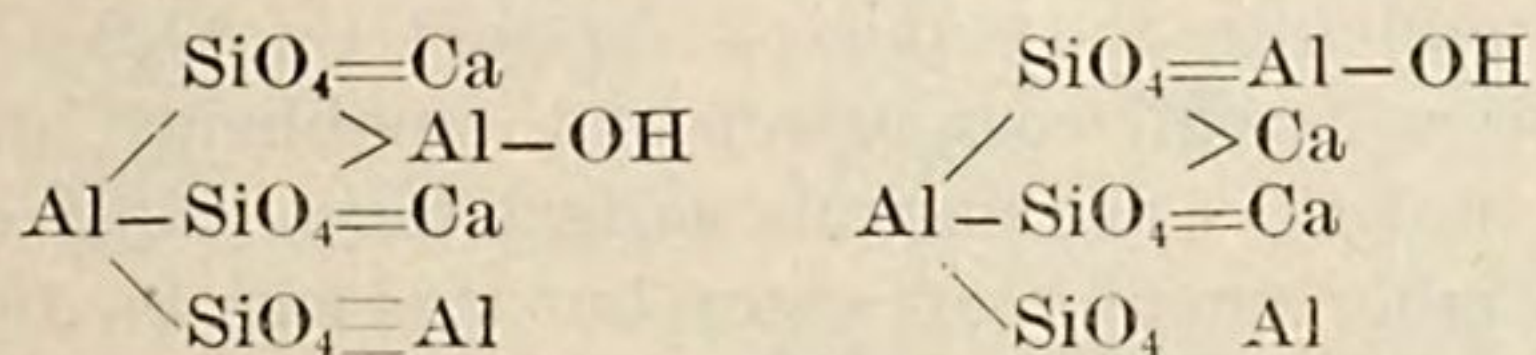
Taking now the formula of a typical garnet, $\text{Al}_2(\text{SiO}_4)_3\text{Ca}_3$, the question of its molecular structure remains to be considered. Regarding it as a derivative of the normal salt $\text{Al}_4(\text{SiO}_4)_3$, it may be written in at least two ways, thus:



That is, isomerism is possible; and of the two species partschinite and spessartite, one may belong to one type and the other to the other.

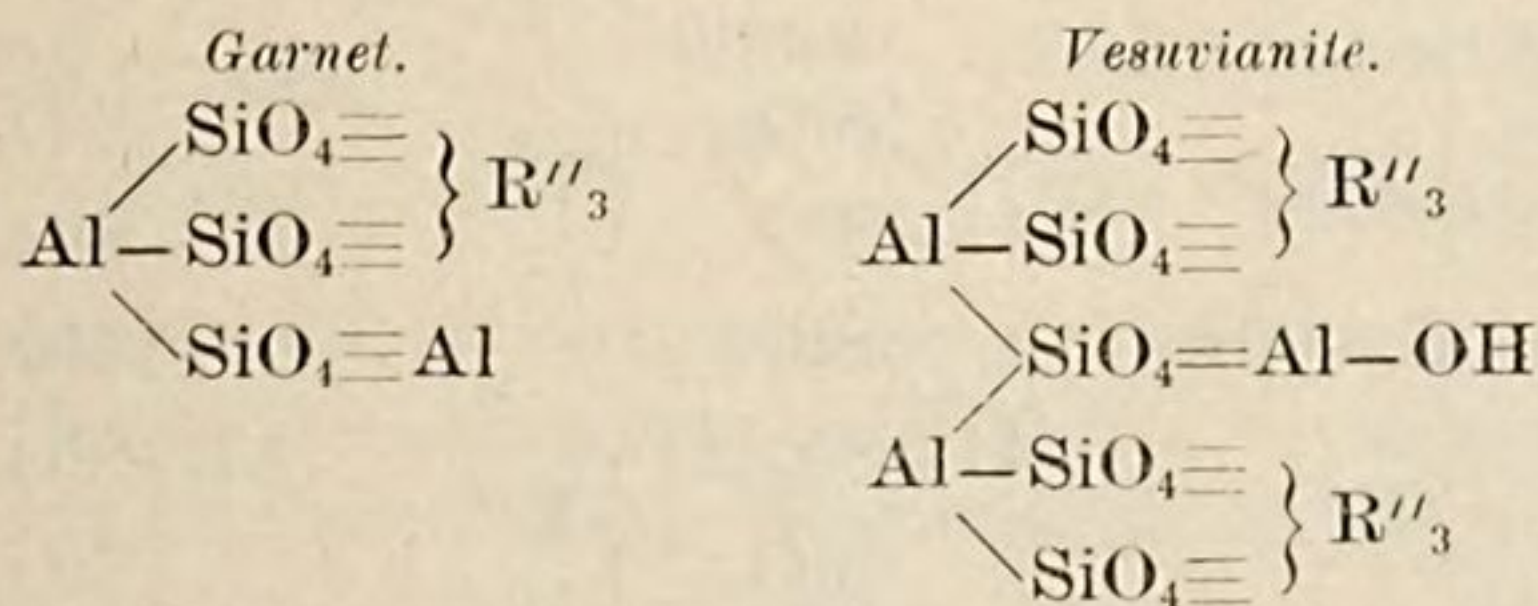
In the first expression there is still a replaceable atom of aluminum, in the second expression none; in the first, at least, one calcium atom must link two SiO_4 groups, while in the other no such linkage occurs; and these facts may be connected with others. For example, garnet alters into mica; and the mica group, as will be seen later, contains members in which the third aluminum atom is replaced. This points at once to the first type of formula as preferable, and the alterability of garnet into epidote brings the latter mineral into the same category.

Zunyite and sodalite, being isometric, should also follow garnet; but derivatives of the second type are theoretically possible and may exist. Even under the first type alone, isomerism is conceivable, and the orthorhombic zoisite may be contrasted with the monoclinic lime epidote as follows:



even though we can not assign either species to either formula definitely. My object here is merely to show that the formulæ have properties by virtue of which they are able to express known differences.

Additional evidence for the formula assigned to garnet is furnished by the composition of vesuvianite, which is most simply represented as formed by the coalescence of two garnet molecules, with elimination of silica. The following formulæ express this relation, and also a relation to epidote, quite perfectly:



If in vesuvianite $\text{R}''_6 = \text{Ca}_5\text{Mg}$, this formula gives for the composition of the typical mineral:

SiO_2	38.38
Al_2O_3	19.55
CaO	35.81
MgO	5.12
H_2O	1.14
	100.00

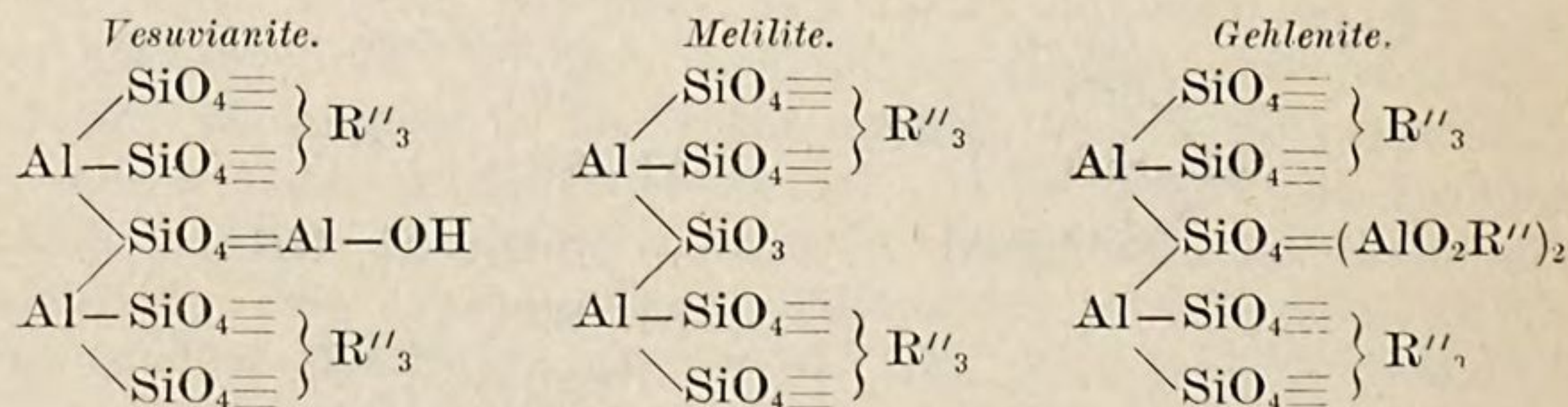
This agrees well with the published analyses, if we remember that ferric iron may partly replace aluminum, and that fluorine sometimes replaces hydroxyl. It is also sustained by the facts that garnet and vesuvianite often occur in contact limestones under similar conditions

of genesis; that vesuvianite alters into garnet, and also, like garnet, into micas and chlorites; and that both species, as shown by Doelter,* yield essentially the same products upon fusion. The analogies connecting them are remarkably suggestive and complete, and the formulæ here proposed render those analogies intelligible. In the Swedish "mangan-idocrase" a salt occurs which is doubtless the vesuvianite equivalent of spessartite, but the compound in a pure state is unknown.

Two additional species, melilite and gehlenite, which, like vesuvianite, are also tetragonal, may perhaps be best considered at this stage of the discussion. For melilite, the analyses are somewhat discordant; but on the whole they agree best with Groth's formula $(\text{CaMgNa}_2)_6(\text{AlFe})_2\text{Si}_5\text{O}_{19}$. This may be written so as to resemble the formula of vesuvianite, but with the linking SiO_4 group replaced by the bivalent SiO_3 . For gehlenite, the empirical formula $\text{Ca}_3\text{Al}_2\text{Si}_2\text{O}_{10}$ is commonly assumed, but a careful comparison of the published analyses has convinced me that it is not entirely satisfactory. Most of the analyses show appreciable amounts of water, but this may be due to alteration; for the artificial gehlenite, prepared by the igneous method, is non-hydrated. A different formula, which relates gehlenite to melilite and vesuvianite, seems to be preferable; and such a formula is empiric-

ally $\text{Ca}_7\text{MgAl}_4\text{Si}_5\text{O}_{24}$. In this the univalent group $-\text{Al} \begin{array}{c} \diagup \text{O} \\ \diagdown \text{O} \end{array} \text{R}''$ is to

be assumed, which occurs also among the clintonite micas, and which, in natural gehlenite, may be replaced in part by $-\text{Al}=(\text{OH})_2$. On this basis the three species are comparable as follows:



These symbols are not absolutely unobjectionable, but they are useful for purposes of correlation. Gehlenite alters into garnet, melilite sometimes occurs among the products of fusion of garnet, and the formulæ suggest such relations. Furthermore, Lemberg† has shown that gehlenite, heated to 200° with a solution of potassium carbonate, gives calcium carbonate and a product having the composition of a potash mica; while similar treatment with sodium carbonate converts the mineral into cancrinite. Gehlenite, garnet, cancrinite, and muscovite are therefore related to one another, and this fact is expressed by the formulæ proposed. In melilite the calcium is partly replaced by sodium, and

*Allgem. Chem. Mineralogie, p. 183.

†Zeitsch. Deutsch. Geolog. Gesell., 1892, p. 237.

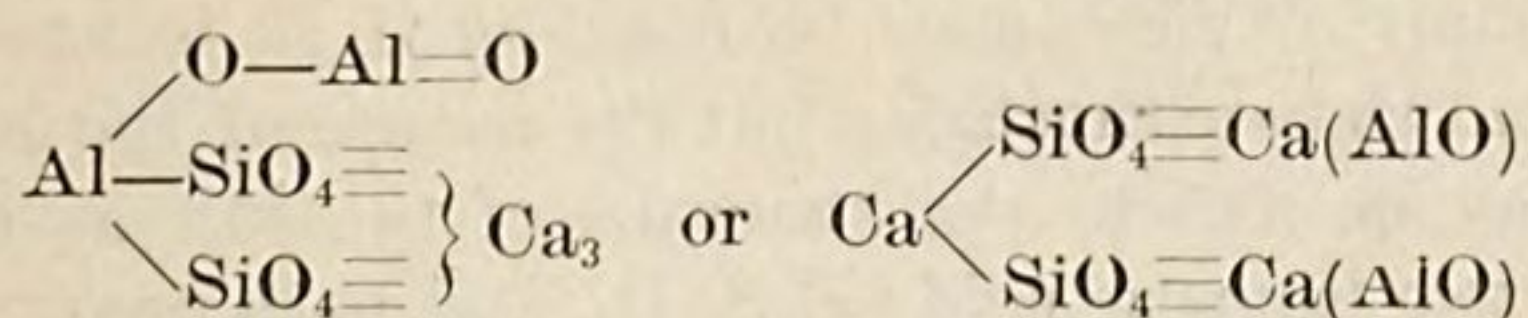
in some gehlenites obtained from furnace slags the same replacement has been observed.*

At the Orawitza locality, gehlenite occurs in rolled pebbles containing grains of vesuvianite. As this gehlenite contains little or no water, we may compare Janovsky's analysis of it† with the results obtained from calculation, both with the formula $\text{Ca}_3\text{Al}_2\text{Si}_2\text{O}_{10}$, and with the new formula $\text{Al}_2(\text{SiO}_4)_5\text{R}''_6(\text{AlO}_2\text{R}'')_2$, when $\text{R}''_8 = \text{Ca}_7\text{Mg}$.

The results are as follows:

	Janovsky.	Old formula.	New formula.
SiO_2	32.39	30.77	32.05
Al_2O_3	18.53	} 26.15	21.80
Fe_2O_3	1.25		
FeO	3.61	} 43.08	41.88
CaO	37.65		
MgO	6.69		
Ign.	.51	-----	-----
	100.63	100.00	100.00

Neither formula compares perfectly with the analysis, but the new is rather better than the old. With some other analyses this advantage is reversed. We need new data, based upon purer and more definite material than seems to have been as yet collected. If the old formula should be sustained, then it might be written structurally in either of two ways, thus:



The first formula would serve to connect gehlenite with garnet and the micas, while the second represents a derivative of calcium orthosilicate and fails to indicate the various relationships of the mineral to other species of this group. Neither formula, however, is so suggestive as the one which is based upon the type of vesuvianite.

Another alternative is offered by the theory of Vogt,‡ who regards melilite and gehlenite as varying mixtures of two end products; one, the "gehlenite silicate," $\text{R}''_2\text{R}''_3\text{Si}_2\text{O}_{10}$, and the other, äkermannite, $\text{R}''_4\text{Si}_3\text{O}_{10}$. The last compound is a basic silicate, found in slags, which needs further study. Vogt's theory is plausible, and, if established, will take the two species in question, gehlenite and melilite, out of the present category as related minerals to vesuvianite and garnet.

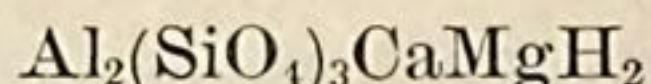
The little-known mineral arctolite is possibly another member of

* See Hintze, Handbuch der Min., p. 310.

† Dana's System of Mineralogy, 6th ed., p. 476.

‡ Neues Jahrb., 1892, II, p. 73.

this group, with affinities toward prehnite. Its composition is fairly expressed by the formula



which is that of prehnite with CaMg in place of Ca_2 . The integrity of this species, however, is not yet fully established.

III. THE FELDSPARS AND SCAPOLITES.

Although orthosilicic and trisilicic acids are technically distinct, and from a chemical point of view should be studied separately, their salts containing aluminum occur in such a variety of mixtures that in several groups of minerals the two acids must be considered as mutually equivalent, and their compounds discussed together. Two such groups, closely allied, are the feldspars and the scapolites.

For each of these groups the theory developed by Tschermak has met with general acceptance. In the case of the feldspars, Tschermak was undoubtedly anticipated in great part by Hunt, Waltershausen, and others, but he gave to the theory its most precise statement, and to him its final establishment is due. According to this theory the triclinic plagioclase feldspars consist of albite, $\text{AlNaSi}_3\text{O}_8$, and anorthite, $\text{Al}_2\text{Ca}(\text{SiO}_4)_2$; which, commingled in various proportions, give the intermediate oligoclase, labradorite, andesite, and so on. There are also the triclinic microcline and its monoclinic equivalent, orthoclase, both represented by the formula AlKSi_3O_8 , and the barium feldspars, such as hyalophane, which may be regarded as mixtures of orthoclase with a barium salt analogous to anorthite in composition. Microcline and orthoclase, from a chemical point of view, may be considered as isomers; and so also may albite and soda-orthoclase; but the nature of the isomerism is not clear. It may be due to the structure of the salt as such, or to the existence of two isomeric acids $\text{H}_4\text{Si}_3\text{O}_8$, and both possibilities are conceivable. For present purposes this problem may be left outstanding, and our attention can be confined to the two typical compounds, anorthite and albite. In the discussion, later, of the species eudidymite and epididymite, the question of isomeric trisilicates will come up.

For the scapolite series Tschermak has elaborated a theory which is closely parallel to that of the feldspars. These tetragonal minerals are shown to be most easily interpretable as mixtures of two end compounds, meionite, $\text{Al}_6\text{Ca}_4\text{Si}_6\text{O}_{25}$, and marialite, $\text{Al}_3\text{Na}_4\text{Si}_9\text{O}_{24}\text{Cl}$. Neither end compound has yet been found in nature quite free from the other; but the variations in composition, in optical character, etc., are all accounted for, and the theory, so far as it goes, is satisfactory. I have tentatively examined some possible alternative hypotheses, and none of them fulfills all necessary conditions so well as this scheme of Tschermak's.

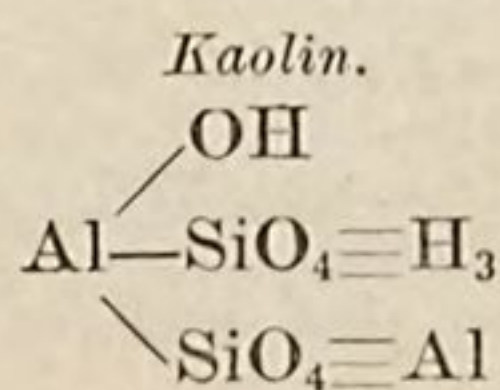
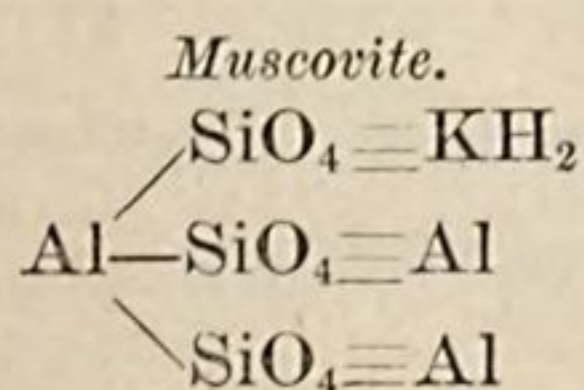
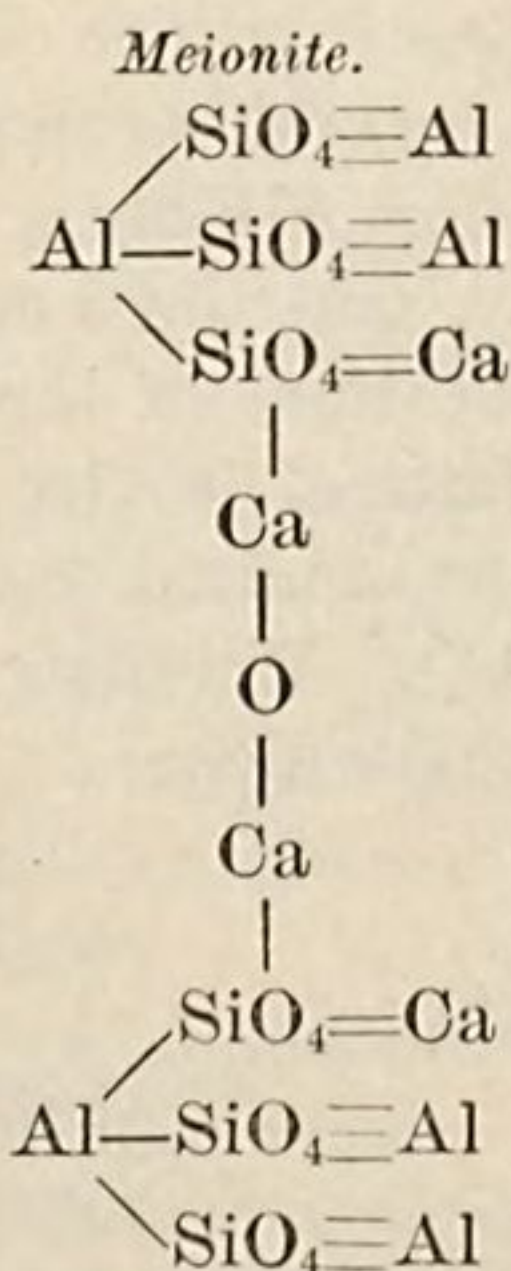
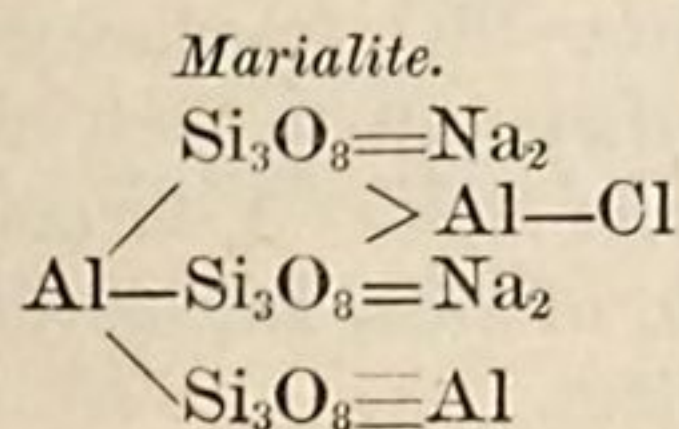
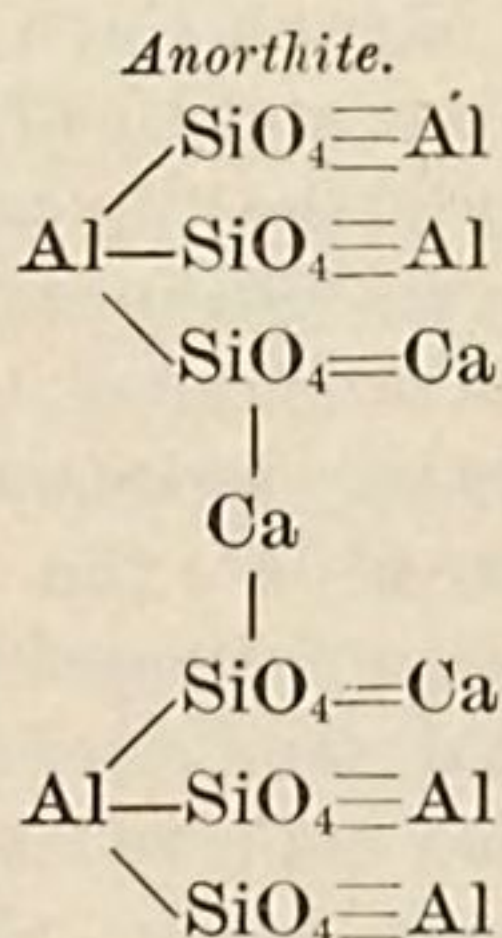
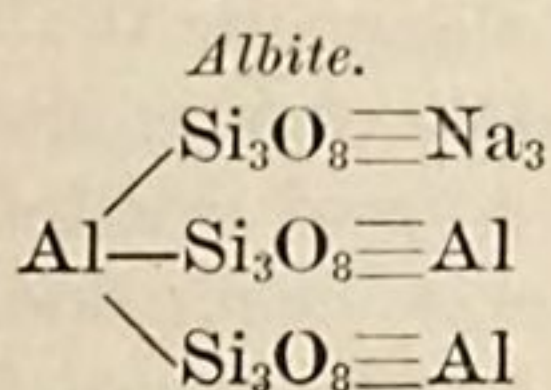
Upon studying the feldspars and scapolites more closely, certain analogies appear other than those indicated by the parallelism of the two series. Both groups of minerals are easily alterable, and both yield kaolin as a final product of the change. Furthermore, both alter into

muscovite, or pinite, which is only an impure pseudomorphous mica; and kaolin, crystallographically, has close relations with the mica family. Feldspars, scapolites, muscovite, and kaolin are therefore presumably connected, and the structural formulæ of the minerals should render the relationship apparent.

The empirical formulæ to be considered are now as follows:

Albite	$\text{AlNaSi}_3\text{O}_8$
Anorthite	$\text{Al}_2\text{CaSi}_2\text{O}_8$
Meionite	$\text{Al}_6\text{Ca}_4\text{Si}_6\text{O}_{25}$
Marialite	$\text{Al}_3\text{Na}_4\text{Si}_9\text{O}_{24}\text{Cl}$
Muscovite	$\text{Al}_3\text{KH}_2\text{Si}_3\text{O}_{12}$
Kaolin	$\text{Al}_2\text{H}_4\text{Si}_2\text{O}_9$

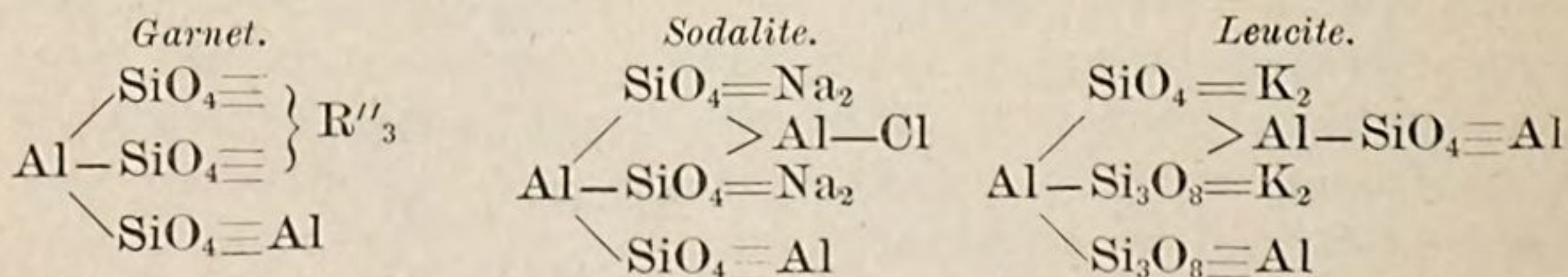
For muscovite the constitution has already been indicated; and this clew, together with the general hypothesis of derivation from normal salts, enables us to correlate all six of the formulæ given. To do this it is necessary to triple the formulæ of albite and anorthite, and we have the following expressions:



On this basis anorthite becomes the calcium equivalent of nephelite, which latter species is also alterable into kaolin. Again, garnets are known to alter into feldspars and scapolite; and, according to Brauns,* in the alteration of diabase, prehnite and epidote are sometimes derived from anorthite. These species, therefore, are all connected by numerous cross relations, all emphasizing one another and pointing to a community of molecular type. I have already called attention to the facts that anorthite and meionite occur among the products of fusion of garnet, and these data fit in well with the others. So far the formulæ are highly suggestive, but as yet they do not indicate the mechanism of the reaction by which a trisilicate feldspar breaks down into kaolin, and they need development in that direction.

Closely allied to the feldspar in its petrographic relations is the isometric mineral leucite, AlKSi_2O_6 . Empirically it seems to be a metasilicate, and is commonly so regarded, but it may easily be conceived as a mixed salt, containing ortho- and trisilicate molecules. By alteration it yields orthoclase, nephelite, muscovite, and kaolin, and the pseudo-leucite of Magnet Cove has been shown by J. F. Williams to consist of orthoclase and elæolite intimately commingled.† This case probably represents the typical breaking up of leucite, the formation of kaolin or of muscovite in other instances being due to secondary reactions. On the other hand, C. and G. Friedel‡ have obtained leucite synthetically from muscovite as a starting point, orthoclase and nephelite being produced at the same time; and Lemberg,§ in his experiments, has transformed leucite into sanidine, anorthite, and microsommite, and also into andesine. In a later paper|| Lemberg describes the action upon various silicates of the salt $\text{Na}_2\text{SiO}_3, 8\text{H}_2\text{O}$, at 200° under pressure, kaolin, albite, elæolite, leucite, and analcite all yielding a silicate-cancrinite containing SiO_3 in place of CO_3 . These facts connect the several species together, but to their explanation the empirical expression AlKSi_2O_6 gives no clew. A formula for leucite, to be satisfactory, must be a multiple of this, and several such multiples fulfill the conditions of the problem.

The isometric form of leucite suggests at once a relation with garnet and the sodalite group, and this can be indicated by the quadrupled formula $\text{Al}_4\text{K}_4\text{Si}_8\text{O}_{24}$. We then have, as a distinct possibility, the following series of molecules:



* Neues Jahrbuch, 1892, II, p. 1.

† Ann. Rept. Geol. Survey of Arkansas, 1890, II, p. 267 et seq.

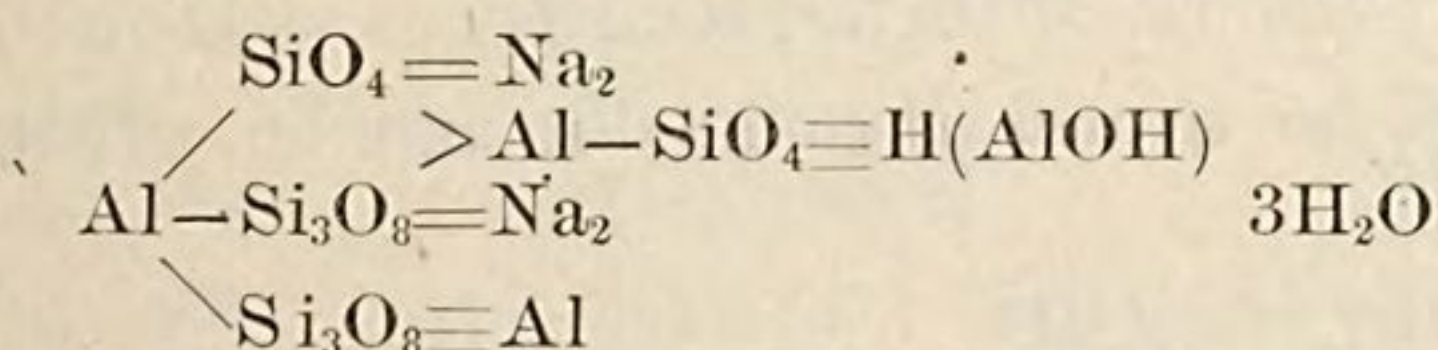
‡ Bull. Soc. Min., XIII, p. 134, 1890.

§ Zeitsch. Geol. Gesell., XXVIII, pp. 611-615, 1876.

|| Zeitsch. Geol. Gesell., pp. 961-2, 1885.

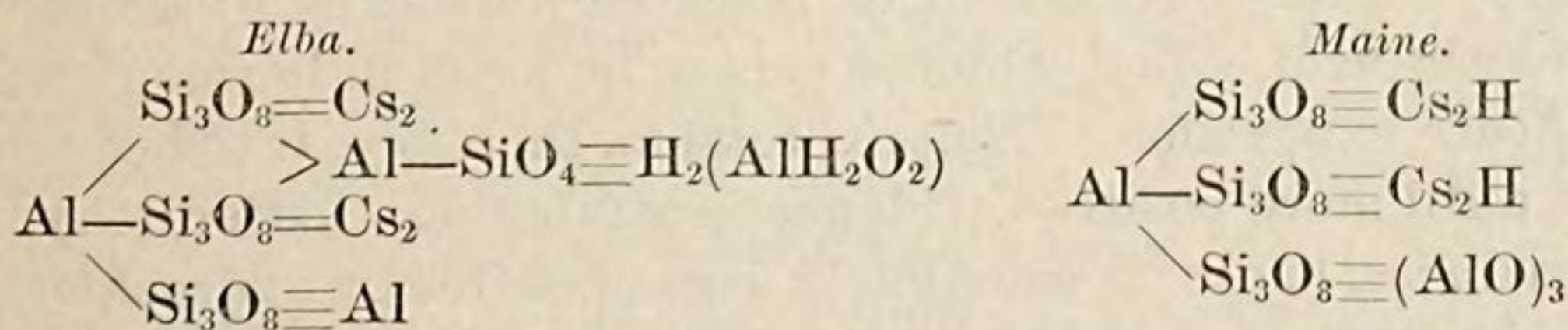
Upon this basis leucite is clearly reduced to the uniform type of the minerals to which it is related crystallographically, and also of those into which it alters; but the formula proposed can not be regarded as final. It is offered here only as a first approximation toward answering the questions which are suggested, and is therefore subject to modification in the future.

Closely allied to leucite is another isometric mineral, analcite, which, empirically, has the composition $\text{AlNaSi}_2\text{O}_6, \text{H}_2\text{O}$. This species alters, like leucite, into feldspar, and an alteration into prehnite is also recorded.* Furthermore, Lemberg has shown, in the papers already cited, that leucite, by the action of soda solutions, may be transformed into analcite, and that analcite, by similar treatment with potash, yields leucite again. With these facts in view, analcite may be written



one-fourth of the water being regarded as constitutional. This last supposition, however, needs to be checked by careful experiments upon dehydration, for the data now on record are not absolutely conclusive.† A change in this detail would modify the formula given, but would not affect its general type.

Still another isometric mineral, pollucite, should possibly be considered here. Two empirical formulæ deserve to be regarded: one, based upon analyses of the Elba mineral, and given by Groth, $\text{H}_2\text{Cs}_2\text{Al}_2\text{Si}_5\text{O}_{15}$; the other, deduced by Wells‡ for the Maine pollucite, $\text{H}_2\text{Cs}_4\text{Al}_4\text{Si}_9\text{O}_{27}$. Both formulæ give metasilicate ratios, but both are reducible to the type of leucite and analcite, thus:



Neither formula can be regarded as conclusive, and their only value here is to show that pollucite is not necessarily a metasilicate, and that it can be represented as similar in constitution to the minerals with which it is morphologically allied. Wells's analyses are probably the better; but the formula drawn from the Elba pollucite indicates the closer analogy to leucite and analcite.

Although kaolin, mineralogically, is not a member of the feldspar group, it is properly discussable here as a derivative. The formula assigned to it in the foregoing pages is not unimpeachable, but it suggests its relations to the feldspars and micas, and also represents the

* Dana's System of Mineralogy, 6th ed., p. 598.

† Compare Hersch, *Der Wassergehalt der Zeolithe*, Zürich, 1887.

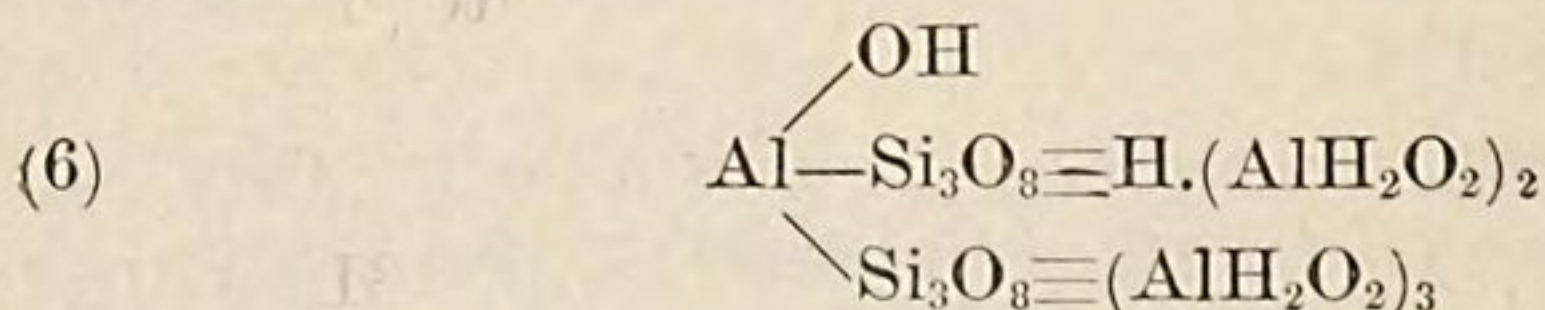
‡ *Am. Jour. Sci.* (3) XLI, p. 213, 1891.

fact that the water in it is wholly constitutional. In fact, the mineral is stable far above the ordinary temperatures of dehydration, so that the water can be regarded only as an essential part of the molecule.

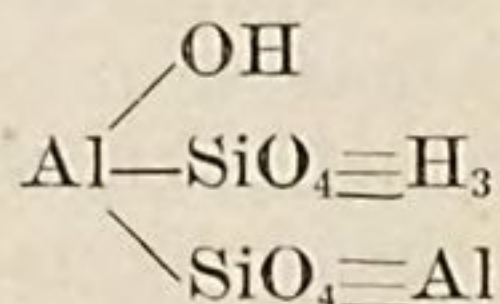
In addition to the formula proposed for kaolin, the following expressions are possible without assumption of any higher molecular weight:

- (1) $\text{Si}_2\text{O}_7 \cdot \text{H}_4(\text{AlO})_2$
- (2) $\text{Si}_2\text{O}_7 \cdot \text{H}_2(\text{AlOH})_2$. Brauns's.
- (3) $\text{Si}_2\text{O}_5 \cdot (\text{AlH}_2\text{O}_2)_2$. Groth's.
- (4)
$$\text{H}-\text{O}-\text{Al} \begin{cases} \text{SiO}_3-\text{AlH}_2\text{O}_2 \\ \text{SiO}_3-\text{H} \end{cases}$$
- (5)
$$\text{O} \begin{cases} \text{Al}=\text{SiO}_4=\text{H}_2 \\ \text{Al}=\text{SiO}_4=\text{H}_2 \end{cases}$$

If the formula be tripled, then kaolin may be written as a basic trisilicate, thus:



Of all these symbols only the last and the one originally chosen indicate the relations between kaolin and its parent species. As for these two, the formula



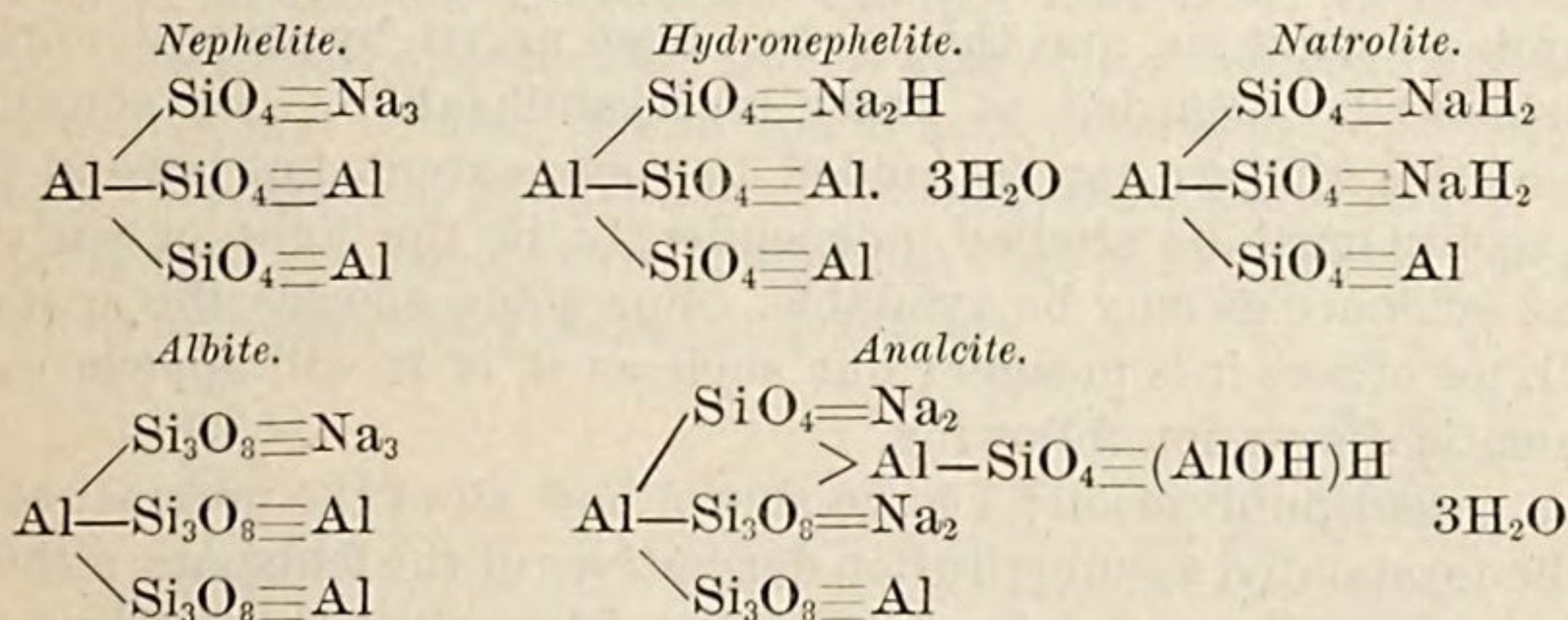
is the simpler, and would seem to represent the greater stability. Kaolin, under ordinary circumstances, is scarcely attacked by the strongest hydrochloric acid, a fact which seems to be most in harmony with the orthosilicate expression. That expression, therefore, is to be preferred; at least until more positive evidence is attainable. After dehydration at low redness, kaolin is completely decomposable by hydrochloric acid, but the ignited mass contains no silica soluble in sodium carbonate solution. These facts, developed by experiments made under my direction by Mr. George Steiger, seem to indicate the formation of a salt $\text{Al}_3\text{Si}_2\text{O}_7$ as the result of ignition, but other interpretations are possible. The data are given here simply as data, which may become available for a fuller discussion of the problem by and by. It will be seen later, when the other clays are considered, that their formulæ are in harmony with that chosen for kaolin.

IV. THE NORMAL ZEOLITES.

By this title is indicated a well-defined group of hydrous silicates, unmistakably related to nephelite and the feldspars, and for which the term *feldspathic zeolites* would be equally appropriate. A few zeolitic species, ptilolite, mordenite, laubanite, etc., are excluded from the present

scheme, as being from a chemical point of view more properly placed elsewhere.

Three of the minerals in this group have already been mentioned, namely, hydronephelite, natrolite, and analcite. All of these occur as alteration products of elæolite or nephelite,* and natrolite yields nephelite again upon fusion. Natrolite and analcite are both derivable by natural processes from albite;† analcite, as shown in the preceding section, yields feldspathic pseudomorphs, and the relations of analcite to leucite are beyond controversy. From sodalite, both natrolite and hydronephelite may be generated, and from nephelite, by artificial means, Doelter has produced analcite and natrolite.‡ All of these relations, with others, both morphological and genetic, are covered by the formulæ which have already been developed, but which, in part at least, may be advantageously repeated here. Thus we have:



For the full significance of these expressions the previous sections must be consulted; the analcite formula being correlated with the formulæ of garnet, leucite, and the minerals of the sodalite group.

In a similar way, but rather less completely, many zeolitic minerals may be connected with anorthite, the calcium end of the plagioclase feldspar series. For example, by heating anorthite with freshly precipitated silica and carbonic acid water at 200° , Doelter obtained heulandite.§ The same investigator, after fusion of various zeolites and subsequent slow cooling, found anorthite among the substances produced by chabazite, heulandite, stilbite, scolecite, laumontite, and thomsonite.|| In some cases anorthite was the chief product of fusion; in others it was subordinate to something else. Again, by various wet reactions, some of them unfortunately involving several stages, Lemberg has generated analcite¶ from chabazite, gmelinite, laumontite, harmotome, phillipsite, stilbite, and heulandite, in some cases studying several varieties of the same species. It is clear, therefore, that the connection between the zeolites and the feldspars is unquestionable, and it

* See Brögger, Zeit. Kryst. Min., XVI, p. 223 et seq.

† Neues Jahrb., 1892, II, p. 1; Brauns.

‡ Neues Jahrb., 1890, I, p. 134.

§ Neues Jahrb., 1890, I, p. 128, et seq.

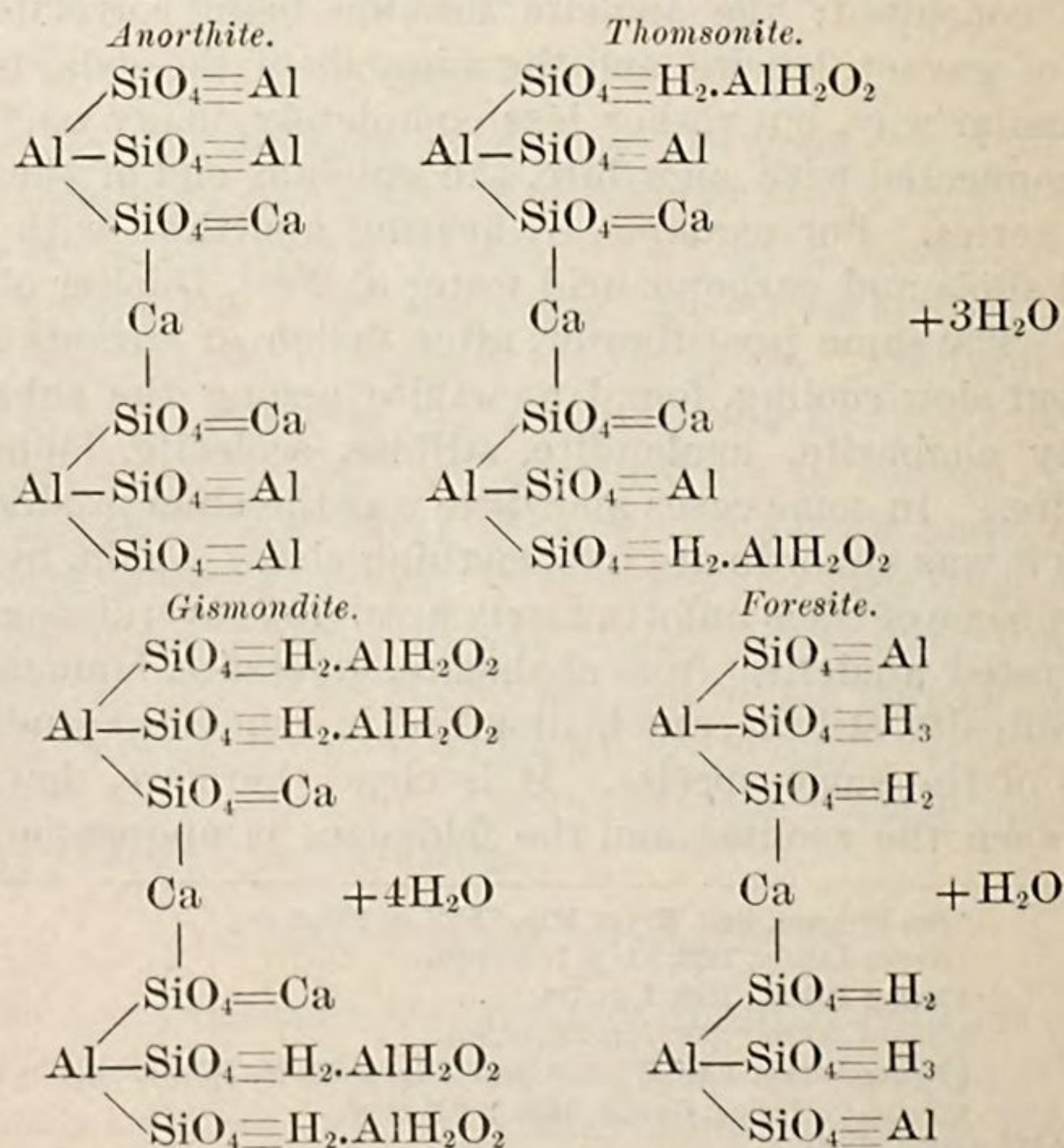
|| Neues Jahrb., 1890, I, p. 118, and Allgem. Chem. Mineralogie, p. 183.

¶ Zeitsch. Geolog. Gesell., 1885, p. 959 et seq.

only remains to work out the details for each individual mineral. The fundamental relations between the two groups have been recognized by many writers; but their interpretations have been diverse.

In the systematic treatment of the zeolites, the most serious difficulty is found in the hydration of the several species. To determine in any case what part of the water is constitutional and what crystalline is not easy, and no fixed criterion exists upon which judgment may be based. Water which is retained by a mineral above 300° of temperature is almost certainly constitutional; water lost at or below 100° is probably water of crystallization; but between the two there is a range of considerable vagueness. There is, however, one datum which has claims to high consideration. Certain zeolites, at various temperatures between the limits indicated, lose water which is regained without change of crystalline character upon subsequent exposure of the minerals to moist air, and this, as has been urged by several authorities, should be regarded as water of crystallization. By considerations of this kind we can be guided to some extent, but beyond them each zeolite must be studied independently, in the light of such collateral evidence as may be available. For some species the evidence is full, for others it is meager; but such as it is it will appear in the systematic discussion following.

In a recent publication* I have shown how all of the normal zeolites may be formulated as substitution derivatives of the feldspars, although in some cases alternative formulæ are readily conceivable. Thus, from anorthite several species are directly derivable, as follows:



* Am. Jour. Sci. (3), XLVIII, p. 187, 1894.

Of these formulæ, the last one, that of foresite, is uncertain, on account of great variations in the published analyses. It is therefore to be regarded as approximate only, and as peculiarly subject to revision. For gismondite the composition is empirically that given by Dana, and the calcium is partly replaceable by potassium. Gismondite is said to give off one-third of its water at 100° , and in the formula that amount is represented as water of crystallization. For thomsonite the evidence is much fuller. Here four-sevenths of the water is regarded as constitutional, a proportion which is fairly in accord with the data by Damour and by Hersch, as cited in Dana.* In nature thomsonite often occurs as a derivative of elæolite, while, according to Doelter (loc. cit.), it yields anorthite upon fusion. In some cases thomsonite, variety mesole, carries an excess of silica, which may be attributed to an admixture of trisilicate groups; that is, to Si_3O_8 replacing SiO_4 . In a thomsonite derived from a plagioclase feldspar this should be expected, and so also should the almost invariable replacement of a part of the calcium by sodium. Nonsodic thomsonite exists, but is probably rare. A thomsonite containing Ca_2Na_2 in place of Ca_3 would have the following theoretical composition:

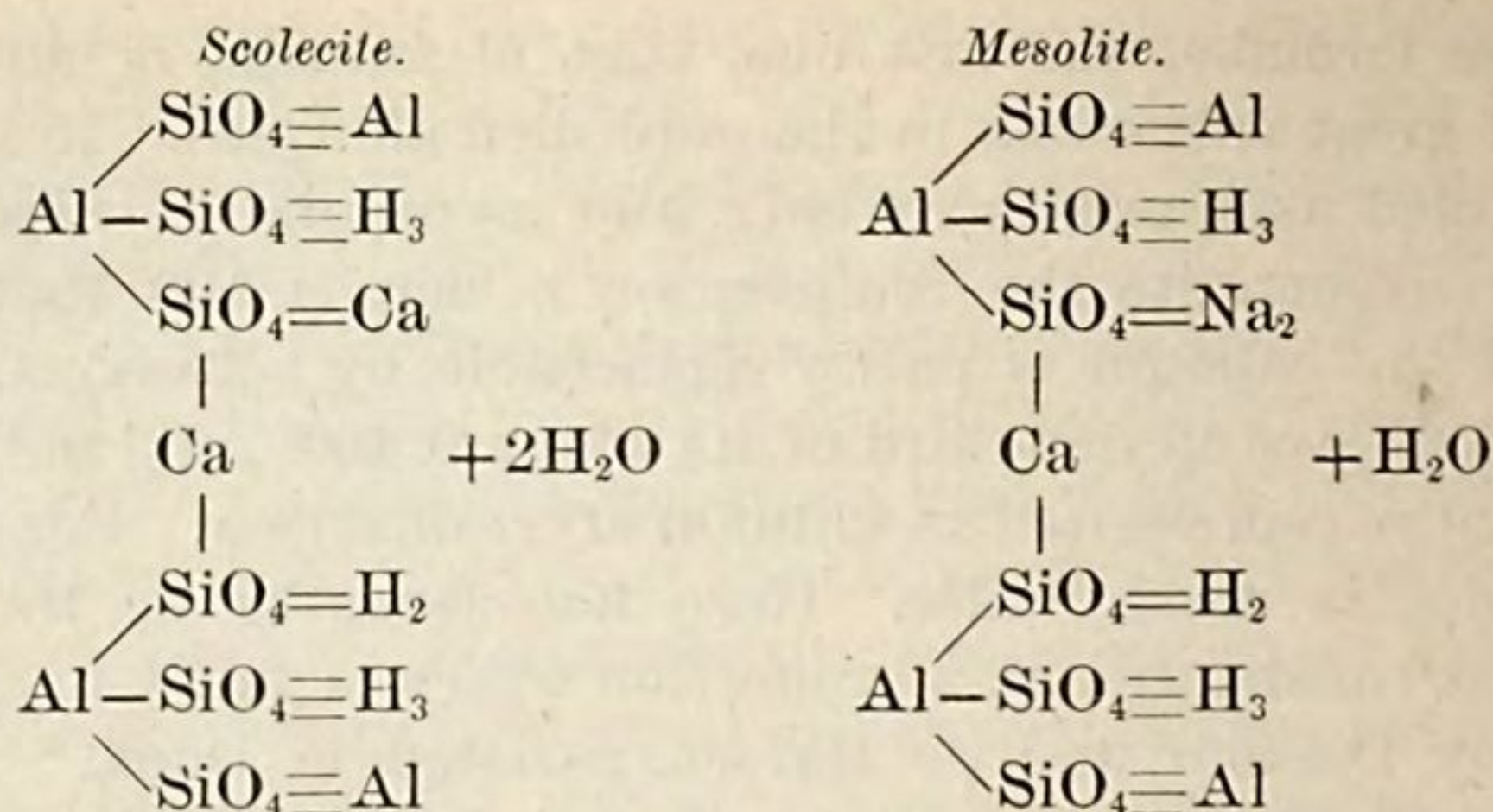
SiO_2	37.27
Al_2O_3	31.68
CaO	11.59
Na_2O	6.42
H_2O	13.04
	100.00
$\frac{3}{7}\text{H}_2\text{O}$ (water of crystallization)	5.59

This agrees well with published analyses, so that the formula proposed satisfies all the conditions imposed by the evidence and also by the general substitution theory.

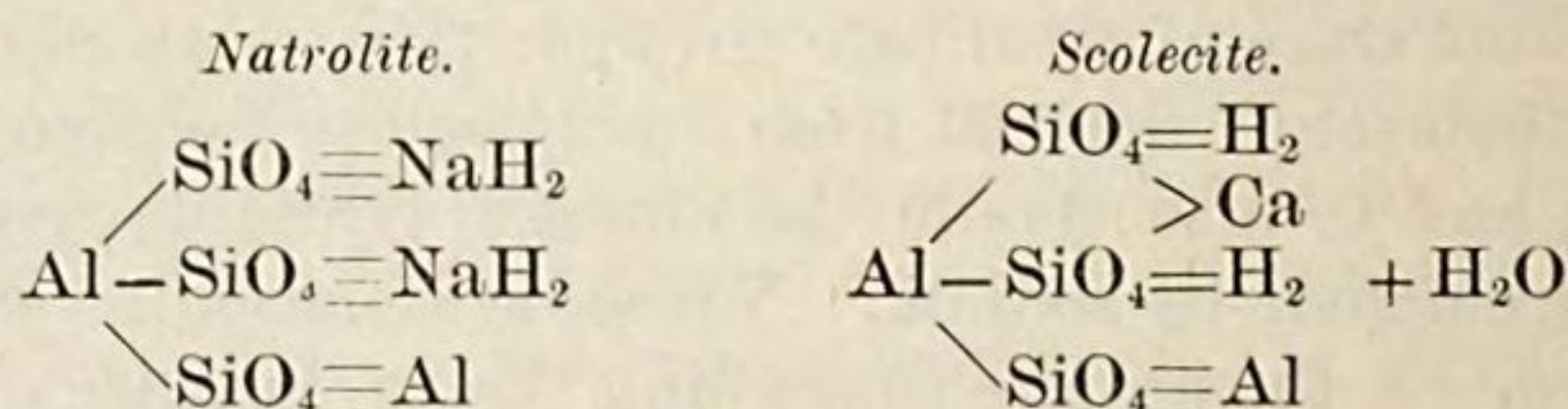
In scolecite, $\text{Al}_4\text{Ca}_2\text{H}_8(\text{SiO}_4)_6 \cdot 2\text{H}_2\text{O}$, we find a zeolite with relations to natrolite on one side and to anorthite on the other. Approximately one-third of its water is given off at temperatures below 300° , to be taken up again in moist air, and on fusion, according to Doelter, it yields anorthite. By the slow action of soda solutions it is transformed into natrolite and mesolite, while natrolite, by means of calcium chloride, is convertible into scolecite.† Mesolite, which is intermediate between natrolite and scolecite, may be regarded as a mixture of the two, or it may be formulated as an independent compound. Written on the anorthite type, scolecite and mesolite become

*Syst. Min., 6th ed., p. 608. Compare Hersch, Der Wassergehalt der Zeolithe, Zürich, 1887.

†Lemberg, Zeitsch. Geol. Gesell., XXVIII, p. 551, 1876.



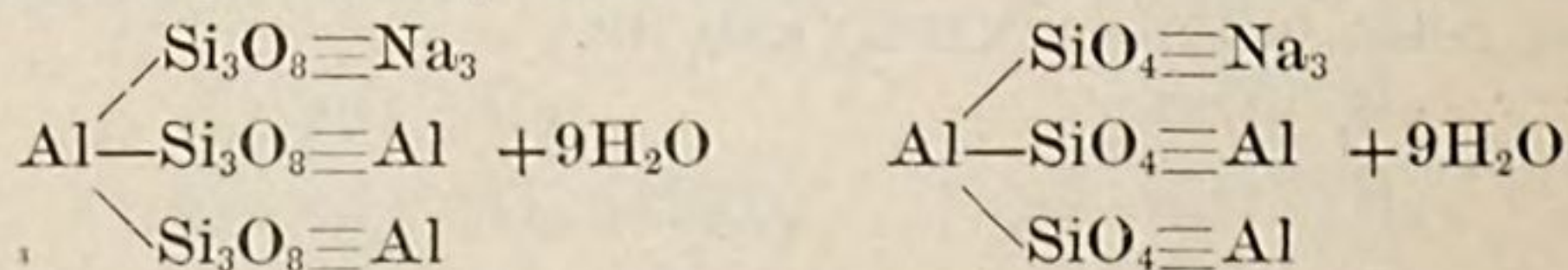
the two species being possibly miscible. On the other hand, the scolecite formula may be halved and correlated with that of natrolite, thus:



Both formulæ for scolecite satisfy the evidence, but between them it is difficult to decide. The existence of mesolite may perhaps turn the scale in favor of the anorthite structure.

By the action of barium chloride solution upon an artificial natrolite, Lemberg* obtained a barium compound which may be the equivalent of scolecite. It is also near the tetragonal edingtonite in composition. The evidence as to the constitution of edingtonite, however, is very imperfect, and dehydration data are entirely wanting. It may also be represented as the barium equivalent of the monoclinic gismondite, the difference in form being due to a difference of combination on the part of the water. At all events, it is highly probable that edingtonite is a derivative of a barium feldspar.

In the rhombohedral zeolites, gmelinite, levynite, and chabazite with its varieties, the ratios are approximately metasilicate, but somewhat variable. In this respect they resemble the feldspars, and the pseudo-metasilicate character is ascribable to mixtures of ortho- and trisilicates, with sometimes one and sometimes the other predominating. Gmelinite is essentially a sodium zeolite, with comparatively little or no lime in its composition, and when lime is present it can be attributed to a hydrous anorthite with 18 molecules of water. Apart from the lime, gmelinite is easily interpreted as a mixture of two silicates of precisely similar chemical type; one an albite, and the other its orthosilicic equivalent, thus:

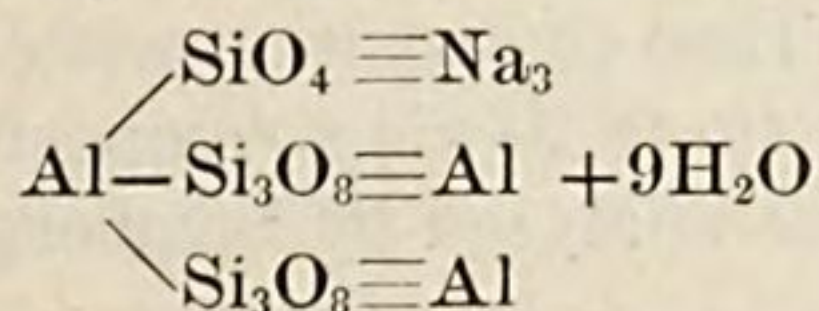


* Zeitsch. Geol. Gesell., XXVIII, p. 553, 1876.

Calculating for mixtures in the ratios of 1:1 and 2:1, we get from these formulæ the following composition of gmelinite, in comparison with analyses by Rammelsberg and by Pirsson:*

	Rammels- berg.	Pirsson.	1:1.	2:1.
SiO ₂	46.48	50.67	46.89	50.89
Al ₂ O ₃	20.64	18.50	19.92	18.21
Fe ₂ O ₃.....	.....	.15	.....	.....
CaO.....	3.78	1.05	} 12.11	11.27
Na ₂ O.....	7.19	9.88		
K ₂ O.....	1.74	.16		
H ₂ O.....	20.41	20.15	21.08	19.63
	100.24	100.56	100.00	100.00

The water is probably all crystalline, thus distinguishing gmelinite from a sodium chabazite; but the evidence on this point is incomplete. Pirsson's analysis may also be represented by a mixed salt of this character:



indicating a relationship to analcite. Such a relation is suggested by the experiments of Lemberg,† who not only derived analcite from the zeolites of this group, but also, starting from fused analcite, obtained a compound approximating to gmelinite in composition.

For chabazite the fundamental ratios are essentially the same as with gmelinite, but the proportions between lime and soda vary greatly. Potassium is also present to a noteworthy extent in some cases, indicating a partial derivation of the mineral from leucite, orthoclase, or microcline. As regards hydration, a part of the water in chabazite appears to be constitutional, probably two molecules out of the nine shown in the gmelinite formula, but this point is not absolutely certain. The evidence in its favor is strong, but not conclusive.

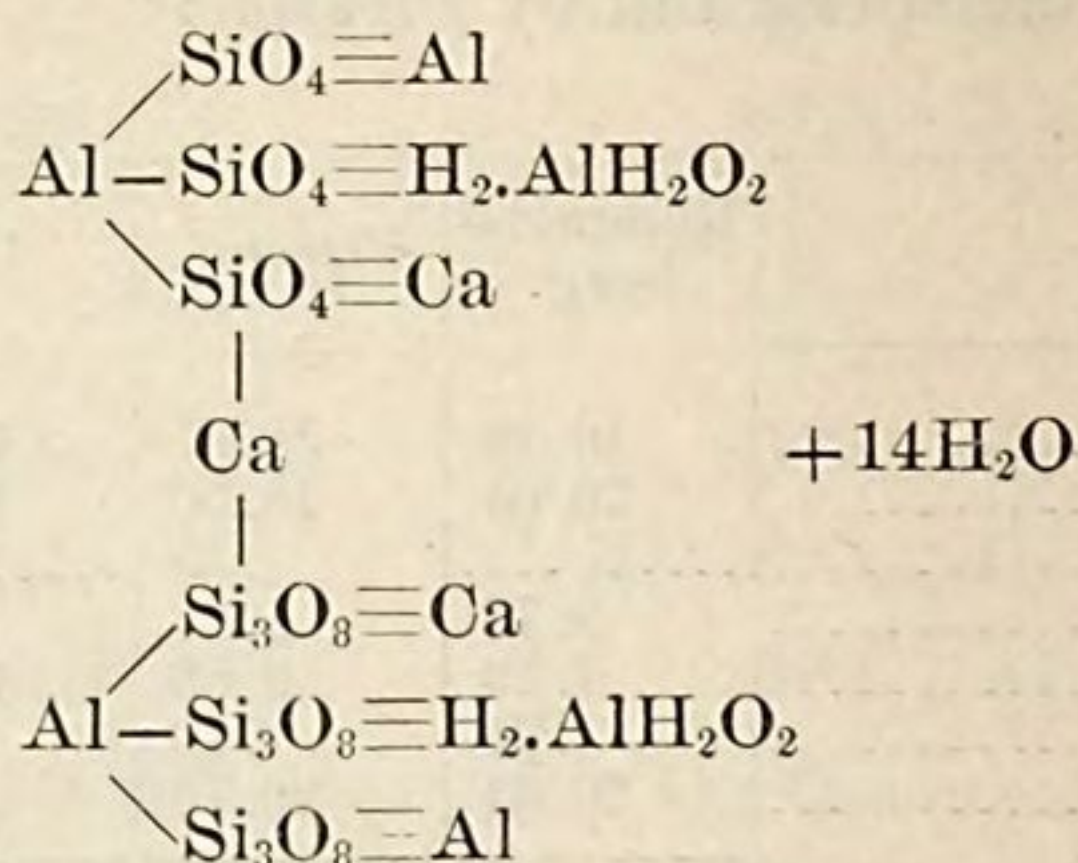
The analyses of chabazite are numerous. Some of them reduce easily to mixtures of anorthite+18 aq. and albite+9 aq., and some, showing little lime, represent isomers of gmelinite. But many chabazites are very low in alkalies, while the ratio between Si₃O₈ and SiO₄ remains practically constant. In these cases it seems necessary to assume the existence of a trisilicate anorthite, or calcium albite, which, by itself, is not known in nature. According to Doelter,‡ chabazite yields upon fusion a mixture of anorthite and silica, a fact which is in harmony

* Dana, 6th ed., p. 594.

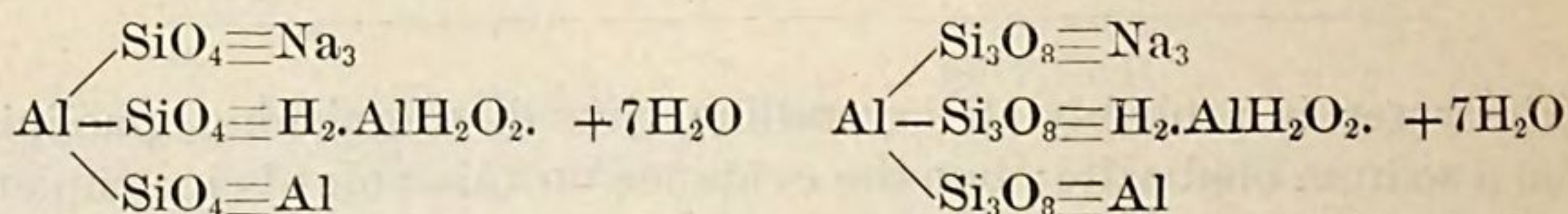
† Zeitsch. Geol. Gesell., 1885, p. 972.

‡ Allgem. Chem. Mineralogie, p. 183.

with the foregoing conjecture. Taking all the data into account, chabazite may be formulated as a mixture of the compound



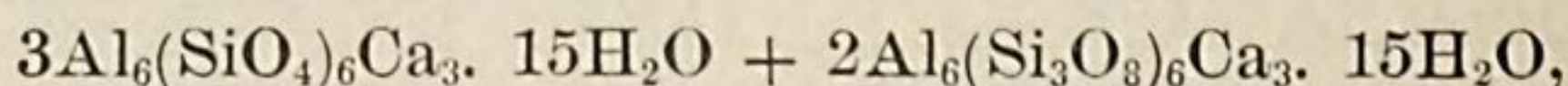
with the salts



the latter being isomeric with the gmelinite molecules. A sodium chabazite agrees in empirical composition with gmelinite, and the calcium salt by itself has the following composition, as compared with chabazite from Aussig, as analyzed by Lemberg:*

	Found.	Calculated.
SiO ₂	47.50	47.43
Al ₂ O ₃	20.00	20.15
CaO	10.20	11.07
Na ₂ O	.23	
K ₂ O	1.24	
H ₂ O	21.40	21.35
	100.57	100.00

It is perfectly evident that the calcium chabazite may also be written as an equimolecular mixture derived from anorthite and its trisilicate equivalent; and in levynite, the last member of the rhombohedral group, we have a mineral of the same type, although differing in hydration. Instead of 18 molecules of water, as in chabazite, levynite contains only 15; but in both cases 4 molecules are to be regarded as constitutional, in accordance with the observations made by Damour. Computing from Hillebrand's analyses,† levynite contains the ortho- and trisilicate molecules in the ratio of 3:2, giving the following empirical composition to the species:



* Analysis No. 4 in Dana's table, Syst. Min., p. 591.

† Bull. U. S. Geol. Surv. No. 20, p. 38.

with the subjoined comparison between observation and theory:

	Found.	Calculated.
SiO ₂	47.76	46.55
Al ₂ O ₃	21.91	21.98
CaO	11.12	} 12.07
Na ₂ O	1.34	
K ₂ O	.21	
H ₂ O	18.65	19.40
	99.99	100.00

Here, as with the preceding minerals of this group, the accordance is quite satisfactory.

One more point with regard to chabazite remains to be noted. According to Kenngott,* a crystal of this mineral, heated to nearly the melting point of glass, retains its form and luster, but loses transparency. If, after cooling, such a dehydrated crystal be moistened with a drop of water, the latter is taken up with evolution of much heat. This observation may possibly imply that the constitutional hydroxyl of chabazite is united wholly or in part with calcium, in which case the formula as written by me should be correspondingly modified. CaOH would appear in it in place of AlH₂O₂, but the fundamental type need not be thereby changed. The question thus raised suggests profitable lines for experimental investigation, which ought to shed much light upon the constitution of this and other allied minerals.

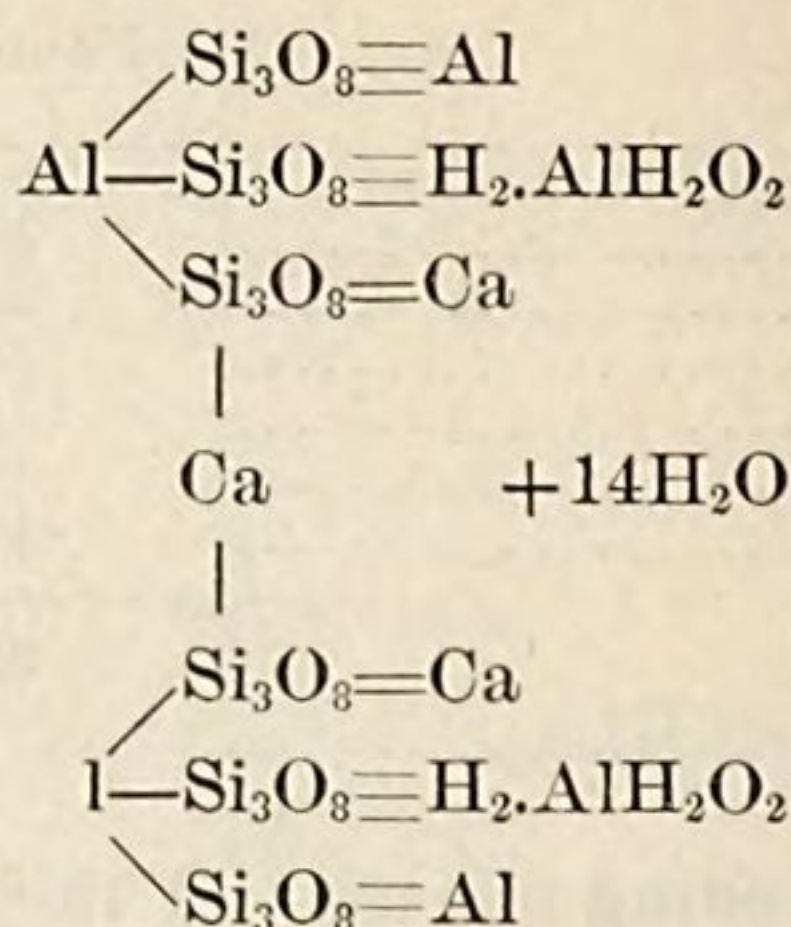
The supposition that the minerals of the chabazite group may be partly derived from a trisilicate anorthite is strongly sustained by the composition of stilbite, which, most typically, is represented by the empirical formula $\text{Ca}_3\text{Al}_6(\text{Si}_3\text{O}_8)_6 + 18\text{H}_2\text{O}$. This requires

SiO ₂	57.51
Al ₂ O ₃	16.29
CaO	8.94
H ₂ O	17.26
	100.00

which agrees with many analyses. Some varieties of stilbite show less silica, which may be due to the presence of orthosilicate molecules, and in most cases a little soda or potash replaces lime. The latter fact represents the presence of albite, elæolite, or orthoclase among the parent minerals of the zeolite, and involves no change in the structure of the molecule. So far as can be determined from the observations of Hersch, about two-ninths of the water in stilbite is retained at moderately high

* Quoted by Hersch, p. 36.

temperatures, and may therefore be regarded as constitutional. On this basis the formula of the mineral becomes



which, in type, resembles that of chabazite, although the two species are crystallographically dissimilar.

To heulandite and epistilbite, two isomeric compounds, essentially the same formula belongs, but with less water of crystallization. Calculated with $\text{Al}_6(\text{Si}_3\text{O}_8)_6\text{Ca}_3.16\text{H}_2\text{O}$, we have for their composition

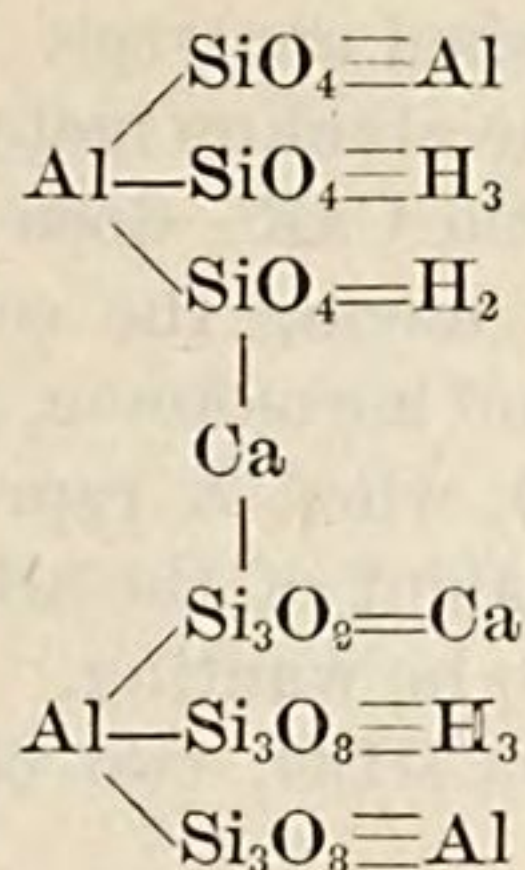
SiO_2	58.63
Al_2O_3	16.61
CaO	9.12
H_2O	15.64
	100.00

in close agreement with analysis. Hersch's work on heulandite shows about three-fourths of the water, or 12 molecules, to be easily expelled, leaving 4 molecules, as in stilbite, constitutional. Hence its structural formula may be written like that of stilbite, with 12 instead of 14 H_2O ; or, $\text{Al}_4(\text{Si}_3\text{O}_8)_6\text{Ca}_3\text{H}_4(\text{AlH}_2\text{O}_2)_2.12\text{H}_2\text{O}$. Brewsterite appears to be like heulandite, but with barium and strontium replacing calcium.

According to Doelter, stilbite and heulandite, on fusion, yield a pyroxenic mineral with silica and an amorphous ground mass, and sometimes also anorthite. The same chemist* also effected the synthesis of heulandite from anorthite by digesting the latter with freshly precipitated silica and carbonated water at a temperature of 200° . These data are but partially interpreted by the constitutional formulæ here given, and for which alternative expressions are possible. A connection with anorthite is established, but the isomerism between heulandite and epistilbite, and the formation of a substance resembling pyroxene from stilbite and heulandite, remain to be accounted for. Possibly epistilbite

* Neues Jahrb., 1890, I, p. 128.

may have the formula already given for this group, while stilbite and heulandite may contain the molecule



plus $8\text{H}_2\text{O}$ in one species and $6\text{H}_2\text{O}$ in the other. This formula was adopted in my former paper on the zeolites, and its configuration, with eight atoms of acid hydrogen, would indicate a complex breaking up upon complete dehydration. Between the two forms of expression, further investigation must decide. Both are in harmony with the fundamental theory, so that the questions at issue are mainly questions of detail.

To stilbite, morphologically, the species harmotome and phillipsite are closely allied. To harmotome may be assigned the formula $\text{Al}_6(\text{SiO}_4)_2(\text{Si}_3\text{O}_8)_4\text{Ba}_3.14\text{H}_2\text{O}$, which requires

SiO_2	45.23
Al_2O_3	16.48
BaO	24.72
H_2O	13.57
	100.00

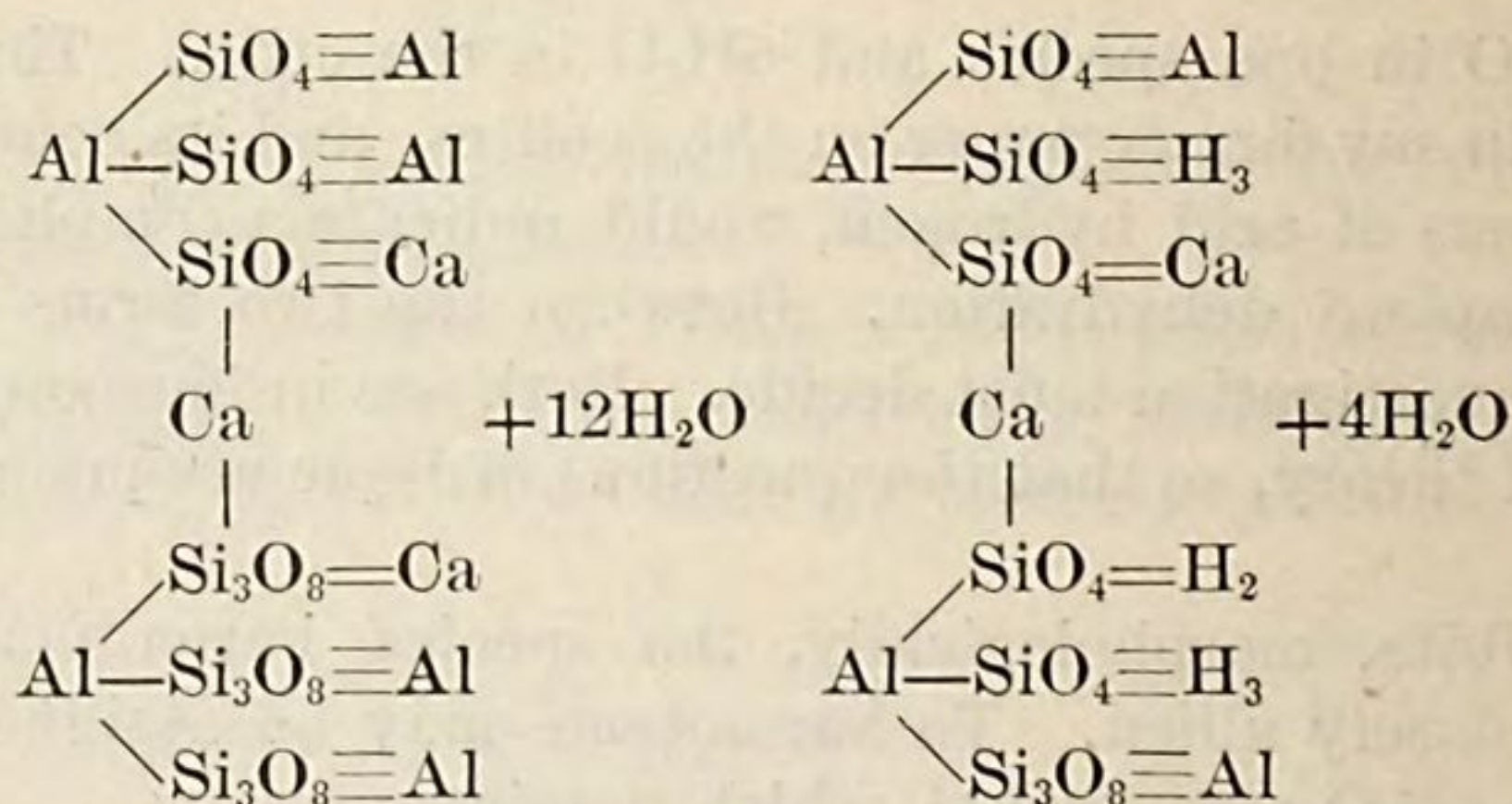
A little barium is commonly replaced by potassium or sodium, perhaps, or even probably as $\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{K}_3.7\text{H}_2\text{O}$, the water being loosely combined and therefore all crystalline. In all probability harmotome is a derivative by hydration of the barium feldspar, hyalophane.

In phillipsite, which, since the investigations of Fresenius, has been generally recognized as the calcium equivalent of harmotome, we find a larger proportion of the bivalent metal replaced by potassium or sodium, and a more variable ratio between SiO_4 and Si_3O_8 . A typical phillipsite approaches nearly to the formula $\text{Al}_6(\text{SiO}_4)_3(\text{Si}_3\text{O}_8)_3\text{Ca}_2\text{K}_2.14\text{H}_2\text{O}$, which requires

SiO_2	48.52
Al_2O_3	20.63
CaO	7.54
K_2O	6.33
H_2O	16.98
	100.00

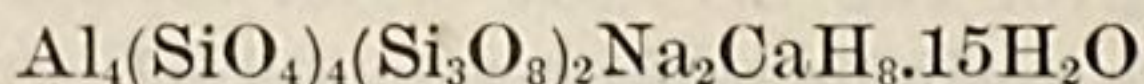
Here again no water is constitutional. In my former paper I assigned to both phillipsite and harmotome a hydration of 15 molecules, but 14 agrees better with the published analyses. In some cases the calcium of phillipsite is lower and the alkaline metals higher than is shown by the ratio Ca_2K_2 , but the ratio CaR'_4 does not appear to be reached, unless by the presence of H among the components of R'_4 . The general formula for phillipsite and harmotome, as shown by all trustworthy analyses, is $\text{Al}_6\text{X}_6\text{R}''_3 \cdot 14\text{H}_2\text{O}$, when X represents $\text{SiO}_4 + \text{Si}_3\text{O}_8$ and R'' is made to include the equivalent of the alkalies. Fusion experiments upon the two species seem to be wanting.

To laumontite, $\text{CaAl}_2\text{Si}_4\text{O}_{12} \cdot 4\text{H}_2\text{O}$, two constitutional formulæ may be assigned, as follows:

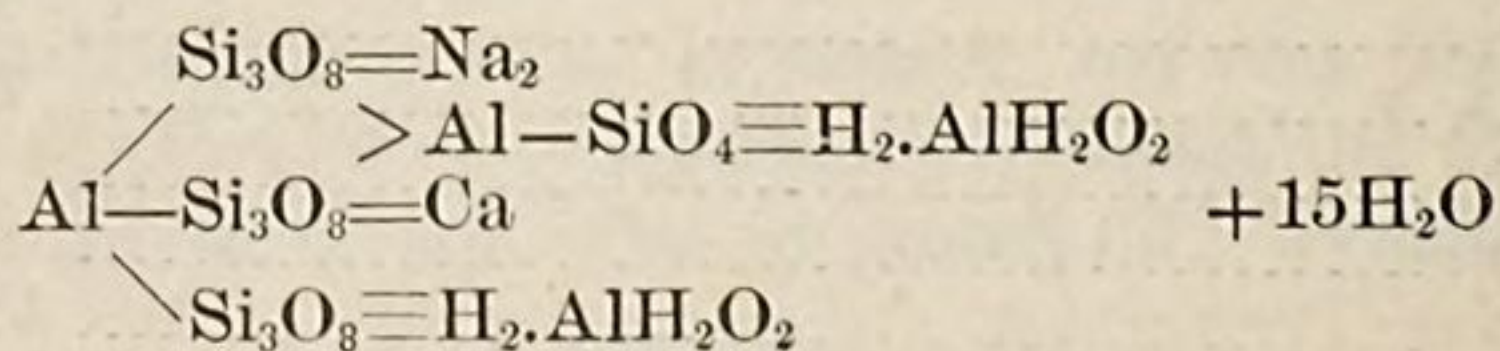


Both expressions give the same empirical composition, but the first is the more symmetrical. The second indicates a ratio between constitutional and crystalline water which agrees with the somewhat incomplete recorded data, but the first is adjustable in such a manner as to represent the same facts. According to Doelter,* laumontite upon fusion gives anorthite, together with a pyroxenic mineral and an amorphous ground mass, and this evidence may harmonize with either formula. A fuller experimental investigation of this species is evidently necessary.

For the isometric faujasite the formula may be written structurally in two ways. One is in uniformity with the expressions assigned to the previous species, and is



The other is based upon the analcite formula, as developed in the preceding chapter, thus:



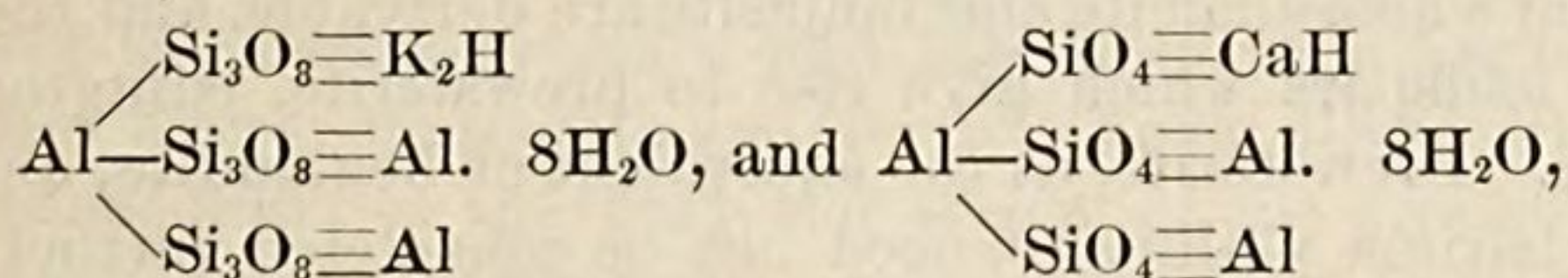
* Neues Jahrb., 1890, I, p. 130.

From these, which are empirically identical, we get the subjoined comparison between theory and the analysis by Damour:*

	Found.	Calculated.
SiO ₂	46.12	47.46
Al ₂ O ₃	16.81	16.14
CaO.....	4.79	4.43
Na ₂ O.....	5.09	4.91
H ₂ O.....	27.02	27.06
15H ₂ O=.....	99.83	100.00
		21.36

According to Jannasch,† faujasite loses 10.88 per cent of water at 105°–110°. At 150° it loses 16.83, about 12 molecules, which is regained in moist air. Between 250° and 260° it loses 22.67 per cent, and the remainder of the water is expelled upon ignition. Of the two formulæ given, the one corresponding to the leucite-analcite type is preferable, for it represents the morphological analogy between the species. Furthermore, faujasite on treatment with hydrochloric acid is decomposed, but does not gelatinize, a fact which may indicate a predominance of trisilicate over orthosilicate groups. This datum, however, is of questionable significance.

One more zeolite, the little-known species offretite, remains to be considered in this connection. This may be represented as a mixture of two molecules,



in the ratio of 2:1. This gives, in comparison with Gonnard's analysis, the following composition:

	Found.‡	Calculated.
SiO ₂	52.47	52.02
Al ₂ O ₃	19.06	18.95
CaO.....	2.43	2.30
K ₂ O.....	7.72	7.77
H ₂ O.....	18.90	18.96
	100.58	100.00

This species is evidently a derivative of orthoclase and anorthite, and the calcium term in the foregoing formula may evidently be written on the anorthite type, namely, as Al₆(SiO₄)₆Ca₂H₂.16H₂O. The

* Dana's System, 6th ed., p. 598.

† Neues Jahrb., 1887, II, p. 24.

‡ Dana's System, 6th ed., p. 1043.

character of its hydration, other than is shown in the formula as given, remains to be determined. The mineral is decomposable by acids with difficulty.

From the evidence given in the foregoing pages the constitutional and genetic connection between the normal zeolites and the feldspars seems to be perfectly clear, and it ought to be easily emphasized by investigations along petrographic lines. Data of this kind, in addition to those already cited, are even now available, and many alterations of the most pertinent kind have been observed. Thus laumontite, heulandite, stilbite, and analcite alter into albite or orthoclase; laumontite and stilbite into analcite; chabazite into natrolite; and gismondite into phillipsite. So also alterations into prehnite are recorded on the part of laumontite, scolecite, mesolite, natrolite, and analcite; and the identity of chemical type seems to be almost unquestionable. From the formulæ here developed all of these alterations become intelligible, and the theory of substitution from normal salts is very emphatically sustained. For the group of zeolites it only remains to summarize the expressions which have been adopted.

For starting points the following minerals are taken:

Nephelite.....	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_3$
Albite and orthoclase.....	$\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{R}'_3$
Anorthite.....	$\text{Al}_6(\text{SiO}_4)_6\text{Ca}_3$
Trisilicic anorthite.....	$\text{Al}_6(\text{Si}_3\text{O}_8)_6\text{Ca}_3$

The last compound is purely hypothetical. To these may be added leucite, from which analcite and faujasite are derivable, and the barium-strontium feldspars which give rise to brewsterite, edingtonite, and harmotome. Brewsterite, as the equivalent of heulandite, and harmotome, as a barium phillipsite, need not be considered further; and as for edingtonite, its constitution is very uncertain. The remaining zeolites are as follows, with the difference between water of constitution and water of crystallization disregarded, except in the few cases in which the distinction affects the integrity of the molecular type. The symbol X is used to express SiO_4 or Si_3O_8 indiscriminately:

Type $\text{Al}_3\text{X}_3\text{R}'_3$.

Hydronephelite.....	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_2\text{H}, 3\text{H}_2\text{O}$
Offretite.....	$\text{Al}_3(\text{SiO}_4)(\text{Si}_3\text{O}_8)_2\text{R}'_3, 8\text{H}_2\text{O}$
Gmelinite.....	$\text{Al}_3(\text{SiO}_4)(\text{Si}_3\text{O}_8)_2\text{Na}_3, 9\text{H}_2\text{O}$

Type $\text{Al}_6\text{X}_6\text{Ca}_3$.

Thomsonite.....	$\text{Al}_6(\text{SiO}_4)_6\text{Ca}_3, 7\text{H}_2\text{O}$
Gismondite.....	$\text{Al}_6(\text{SiO}_4)_6\text{Ca}_3, 12\text{H}_2\text{O}$
Laumontite.....	$\text{Al}_6(\text{SiO}_4)_3(\text{Si}_3\text{O}_8)_3\text{Ca}_3, 12\text{H}_2\text{O}$
Phillipsite.....	$\text{Al}_6(\text{SiO}_4)_3(\text{Si}_3\text{O}_8)_3\text{Ca}_2\text{K}_2, 14\text{H}_2\text{O}$
Levynite.....	$\text{Al}_6\text{X}_6\text{Ca}_3, 15\text{H}_2\text{O}$
Heulandite, epistilbite.....	$\text{Al}_6(\text{Si}_3\text{O}_8)_6\text{Ca}_3, 16\text{H}_2\text{O}$
Stilbite.....	$\text{Al}_6(\text{Si}_3\text{O}_8)_6\text{Ca}_3, 18\text{H}_2\text{O}$
Chabazite.....	$\text{Al}_6(\text{SiO}_4)_3(\text{Si}_3\text{O}_8)_3\text{Ca}_3, 18\text{H}_2\text{O}$

Type $Al_2X_3R'_6$.

Natrolite	$Al_2(SiO_4)_3Na_2H_4$
Prehnite	$Al_2(SiO_4)_3Ca_2H_2$
Scolecite	$Al_2(SiO_4)_3CaH_4, H_2O$

Type $Al_4X_6Ca_6$.

Mesolite	$Al_4(SiO_4)_6CaNa_2H_8, H_2O$
Foresite	$Al_4(SiO_4)_6CaH_{10}, H_2O$

Some of these formulæ are conditioned by the replacements and alternatives cited in the previous pages and in my former paper upon the zeolites, and they are further modified by the character of the hydration. The expressions for analcite and faujasite, as based upon the leucite type, need not be repeated.

The morphological characteristics of the zeolites probably depend in great part upon their mode of hydration, but this point needs to be developed. So also does the relation between zeolites and kaolin, into which the minerals of this group sometimes alter. Furthermore, zeolitic substances of indeterminate nature are believed to exist in soils and clays, and it is conceivable that such bodies may be intermediately formed during the transition from feldspar into kaolin. In studying the mechanism of that change this possibility ought to be considered.

V. THE MICAS AND CHLORITES.

On account of their wide distribution, their variety of composition, and their genetic relations to other species, the micas and chlorites form one of the most instructive and interesting families of minerals. Two of the micas, muscovite and biotite, have already been noted among the members of the first and second of the preceding groups; and we have seen how frequently they arise from the alteration of other silicates, while these in some cases have been synthetically derived from micaceous material.

As regards the substitution theory, the minerals of this family are peculiarly suggestive, for the reason that they form a series of the most complete character. Thus, starting from the normal aluminum ortho-silicate, we have

Normal orthosilicate	$Al_4(SiO_4)_3$
Muscovite	$Al_3(SiO_4)_3KH_2$
Normal biotite	$Al_2(SiO_4)_3Mg_2KH$
Normal phlogopite	$Al(SiO_4)_3Mg_3KH_2$

No further substitution of the same order is possible, for the reason that its formation would remove the linking atom of aluminum, and break up the fundamental molecule.

Muscovite, the first species in the foregoing series, occurs in nature as an independent mineral, and also as an alteration product of nephelite, eucryptite, topaz, andalusite, the feldspars, the scapolites, and various other natural silicates. All of these alterations become

intelligible in the light of the formulæ adopted in this memoir. In its more typical occurrences muscovite agrees sharply with the formula given, but it varies in composition within well-defined limits. First, it ranges toward its sodium equivalent, paragonite, which has the corresponding formula $\text{Al}_3(\text{SiO}_4)_3\text{NaH}_2$. Secondly, in fuchsite, the chromic mica, a chromium salt partly replaces the aluminum compound, and similar ferric replacements are also known. In all of these variations, however, there is no change of ratios, and the typical formula remains undisturbed. In the barium mica, cellacherite, there is possibly a molecule of the type $\text{Al}_3(\text{SiO}_4)_3\text{R}''\text{R}'$, but this is uncertain. Other interpretations of the barium micas are admissible.

The most important variation in muscovite is in the direction of increased silica. Normal muscovite contains 45.3 per cent of SiO_2 , but varieties exist in which the percentage rises to nearly 59. Muscovites of this class have been designated by Tschermak as phengites, and they are most easily explained upon the supposition of trisilicate admixtures. The molecule $\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{KH}_2$ is identical in type with ordinary orthosilicate muscovite, and its presence completely accounts for all excesses of silica over the normal amount. In Sandberger's lepidomorphite, for instance, the orthosilicate and trisilicate molecules occur in nearly equal proportions. All known muscovite may be represented by the general formula $\text{Al}_3(\text{SiO}_4)_3\text{R}'_3 + \text{Al}_3(\text{Si}_3\text{O}_8)_3\text{R}'_3$, in which the latter molecule varies from zero to fifty per cent, and with ferric iron or chromium sometimes replacing aluminum.

With the biotites and phlogopites the variability of composition is even greater than in the case of muscovite. For the typical molecules the composition would be

	$\text{Al}_2(\text{SiO}_4)_3\text{Mg}_2\text{KH}$	$\text{Al}(\text{SiO}_4)_3\text{Mg}_3\text{KH}_2$
SiO_2	43.06	43.27
Al_2O_3	24.40	12.26
MgO	19.14	28.85
K_2O	11.25	11.29
H_2O	2.15	4.33
	100.00	100.00

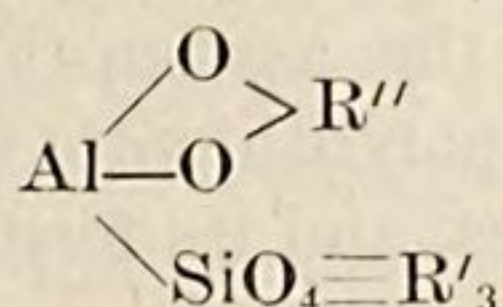
To these types but few natural micas actually correspond, although intermediate mixtures are very common. Furthermore, ferrous salts frequently replace the magnesium compounds, and ferric molecules replace those of aluminum. Manganese, also, sometimes occurs among the dyad bases, and occasionally trisilicates in small amount are commingled with the ortho-salts. Because of these complications, the reduction of a given analysis to a specific formula may be very difficult, and this difficulty is often increased by uncertainty in the determination of water, or of the state of oxidation of the iron. In spite of these difficulties, however, the reduction is generally possible, and the ferro-

magnesian micas, with some exceptions to be noted further on, are representable as mixtures of the two types shown in the formulæ as given. The iron mica siderophyllite agrees closely in composition with a normal ferrous biotite, $\text{Al}_2(\text{SiO}_4)_3\text{Fe}_2\text{KH}$. Aspidolite appears to be a sodium phlogopite, but needs reanalysis. In exceptional cases, muscovitic types seem to exist among these micas, and certain lepidomelanes approximate to the general formula $\text{Al}_3(\text{SiO}_4)_3\text{Fe}''\text{K} + \text{Fe}'''_3(\text{SiO}_4)_3\text{Fe}''\text{K}$. Another unusual mica is Breithaupt's alurgite, which, as analyzed by Penfield,* corresponds to a mixture of molecules

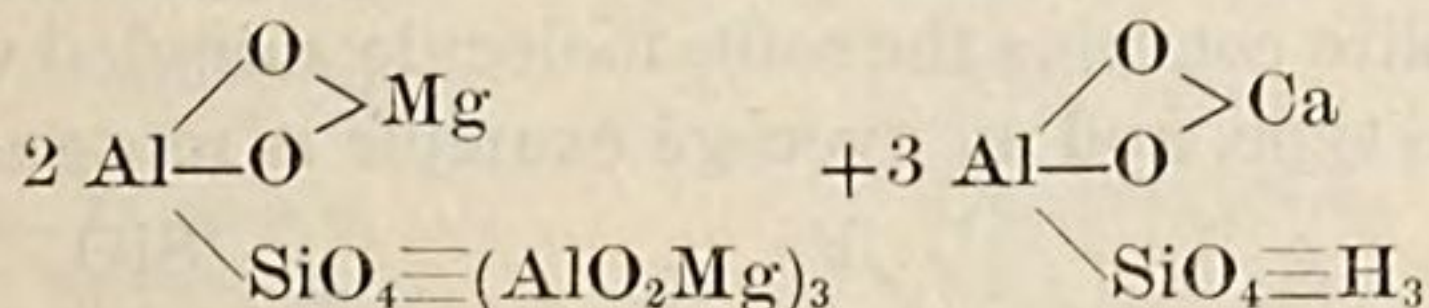
2. $\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{KH}_2$
3. $\text{Al}_2(\text{SiO}_4)_3\text{K}_2\text{H}_4$
3. $\text{Al}_2(\text{SiO}_4)_3\text{Mg}_2\text{KH}$,

with a slight excess of H over K in the last compound. The second of these molecules, an alkaline biotite, is the characteristic feature of alurgite. Similar compounds, parallel to phlogopite, seem also to exist, having the general formula $\text{Al}(\text{SiO}_4)_3\text{R}'_9$; but all of these bodies conform sharply to the general theory of the micas, and are substitution derivatives of the normal aluminum salt.

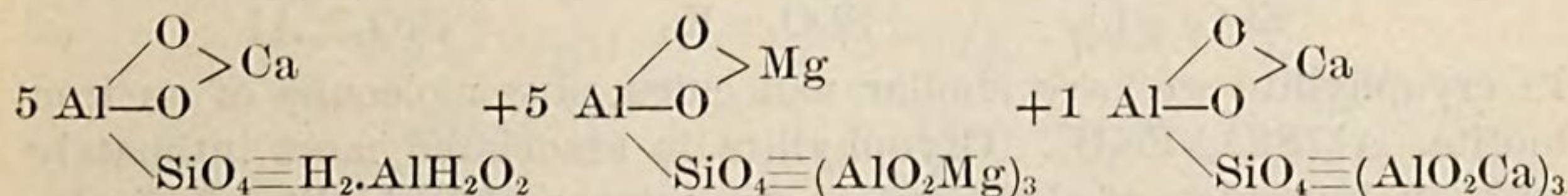
In many of the magnesian micas fluorine is found, and the iron micas frequently contain oxygen in excess of the amount necessary to convert all of the silicon into the radicle SiO_4 . When this excess is real, that is, not ascribable to defective analysis, it may be due either to alteration or to admixtures of micas belonging to the clintonite group. This group, the members of which resemble biotite morphologically, are extremely basic, and are representable by the general formula



in which R'_3 may be replaced by Al, or by $\text{R}''\text{R}'$, R'' being magnesium, calcium, or ferrous iron. The univalent group $\text{AlO}_2\text{R}''$ may also appear in R' , giving as the extreme end of the clintonite series the compound $(\text{AlO}_2\text{R}'')_4\text{SiO}_4$. In seybertite and brandisite we have nearly



while xanthophyllite† is

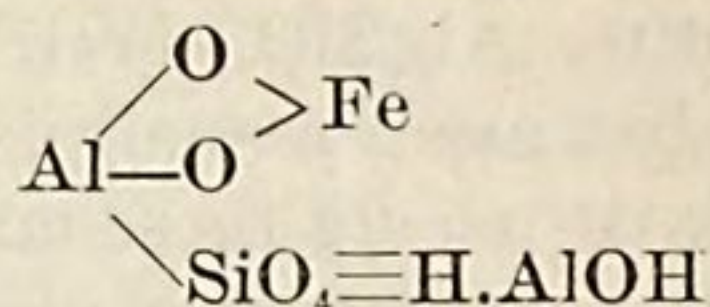


The xanthophyllite, upon ignition, decomposes into a portion soluble and a portion insoluble in hydrochloric acid. The insoluble portion has the composition of spinel, a mineral which is generally found

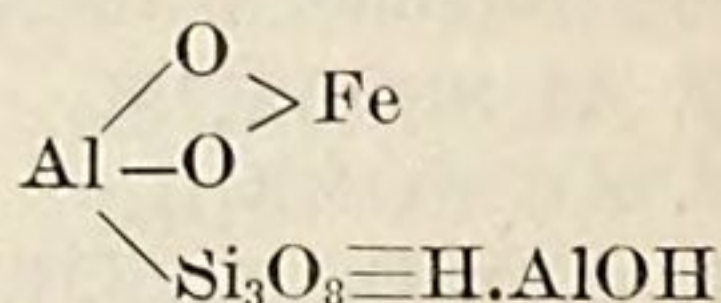
* Am. Jour. Sci., (3) XLVI, p. 289. 1893.

† See Clarke and Schneider, U. S. G. S. Bulletin No. 113, p. 27.

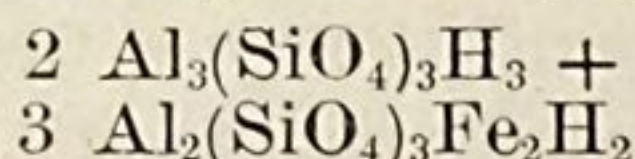
accompanying clintonite micas, and of which the formation is rendered intelligible by the formulæ. Whether chloritoid belongs here or not is doubtful, but if it does its formula may be written



Ottrelite may possibly be essentially the trisilicate equivalent of chloritoid,

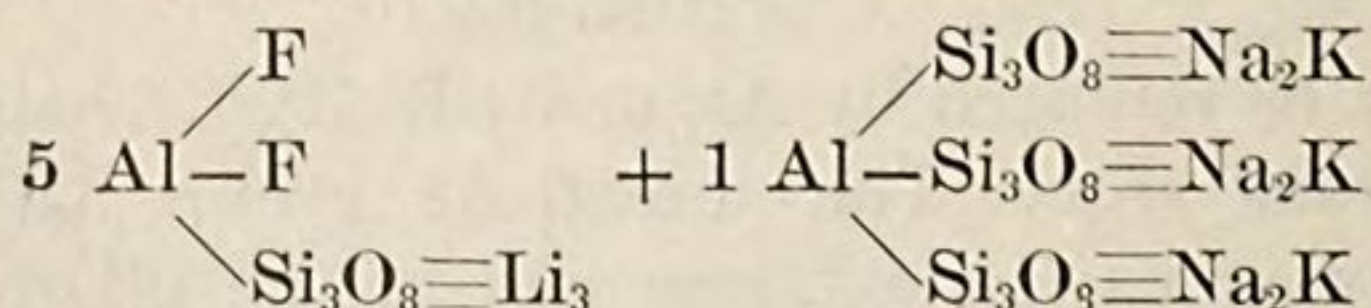


and Damour's venasquite approaches this composition. Variations in composition in ottrelite correspond to mixtures of this molecule with small quantities of chloritoid. Venasquite, however, is also reducible to the normal mica type, and agrees sharply with

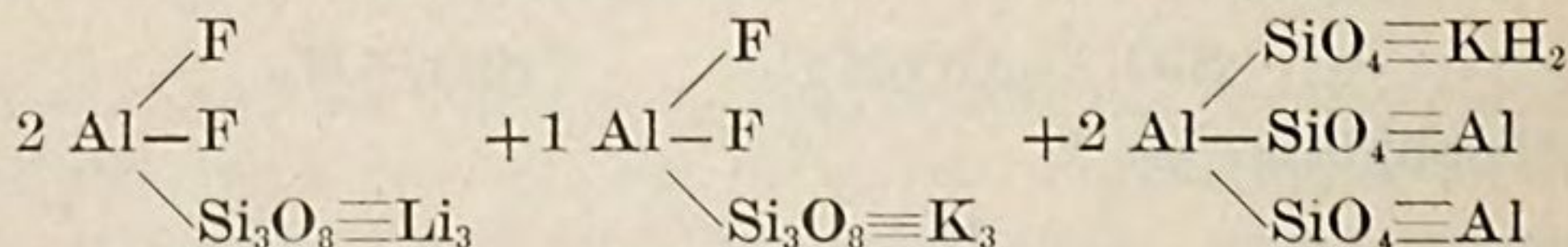


It may be that ottrelite and its varieties represent the first stage intermediate between micas and vermiculites; the alkalies of mica having been replaced by water, all R' becoming H.

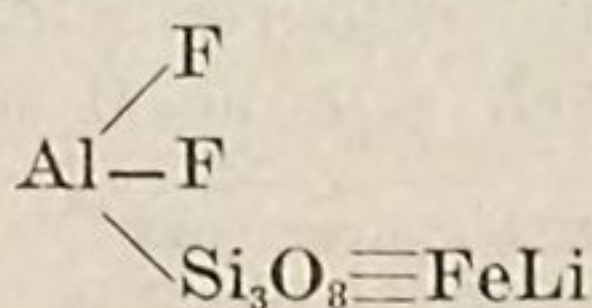
Although fluorine is found in micas of all classes, it is chiefly characteristic of lepidolite, zinnwaldite, and phlogopite, and is generally connected with a low oxygen ratio. Indeed, the extreme end of the lepidolite series, polyolithionite, is entirely trisilicate in character, and its existence fully justifies the assumption that trisilicates occur in other micas. Furthermore, polyolithionite furnishes a clew to the entire lepidolite or lithia mica series, and its formula is easily written



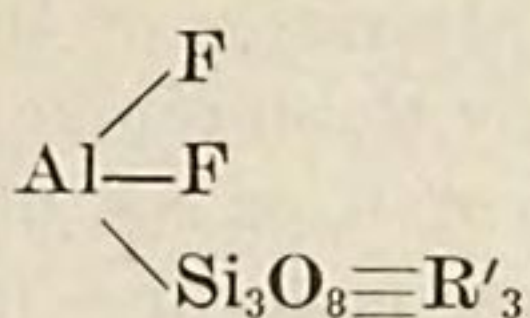
the dominant molecule being akin to clintonite in general constitution. Ordinary lepidolite contains the same molecule, mingled with molecules of the muscovite type, and an average example is represented by



In cryophyllite we have similar molecules, plus molecules of an iron biotite, $\text{Al}_2(\text{SiO}_4)_3\text{Fe}_2\text{H}_2$. Cryophyllite is associated most intimately with an iron mica of that general character, and lepidolite, similarly, is always accompanied by muscovite. In zinnwaldite the molecule

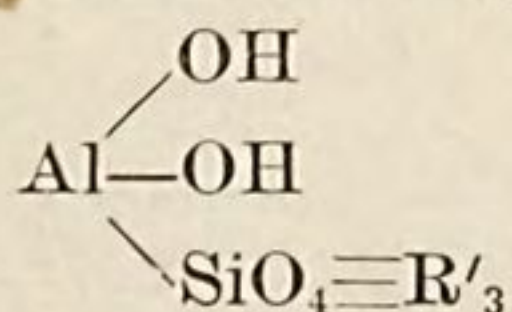


probably occurs, commingled with others of the ordinary lepidolite and muscovite types. In short, all the lithia micas contain compounds of the type

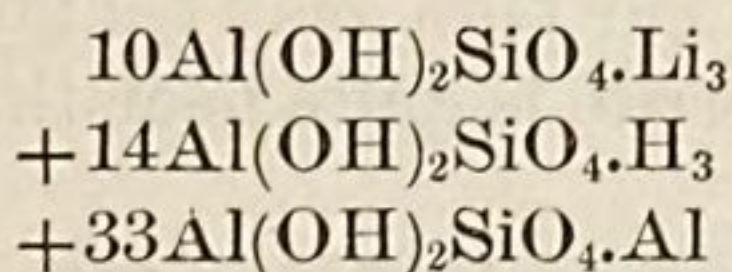


with members of the normal mica series.* The fluoriferous phlogopites may contain molecules of the same character, especially $\text{AlF}_2 \cdot \text{Si}_3\text{O}_8 \cdot \text{MgK}$, or they may be of the normal type with univalent $-\text{Mg}-\text{F}$ among the monad bases. Between these alternatives it is difficult to decide, and more evidence is necessary.

By alteration lepidolite passes into cookeite, a mineral which well illustrates the equivalent character of hydroxyl and fluorine. Penfield's analysis gives for cookeite a general formula,

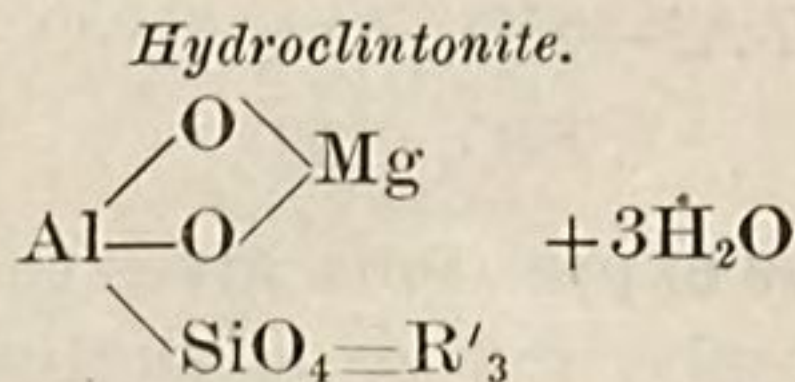
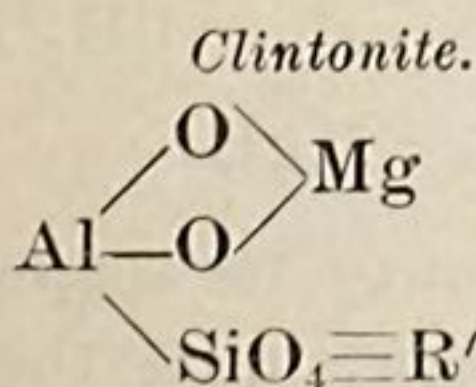
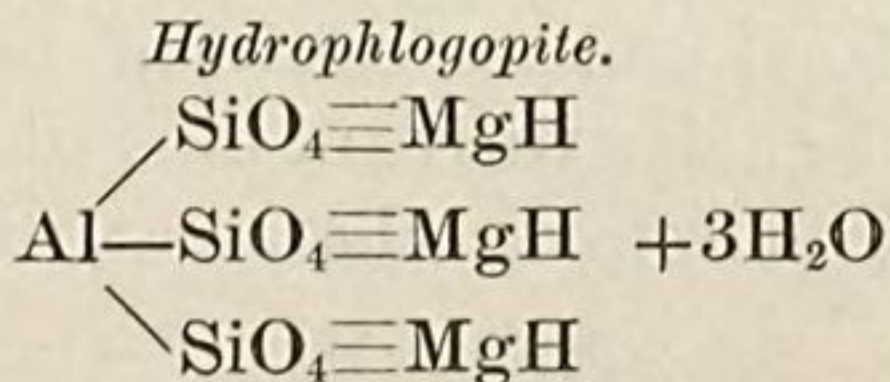
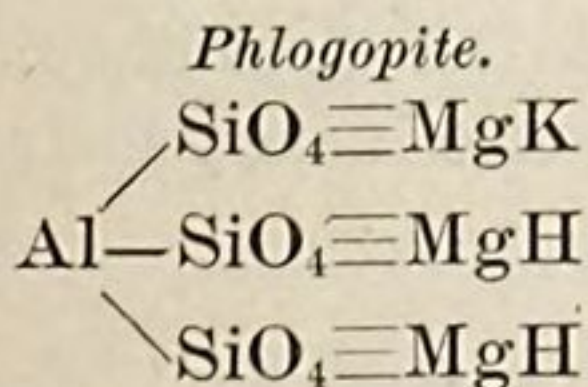
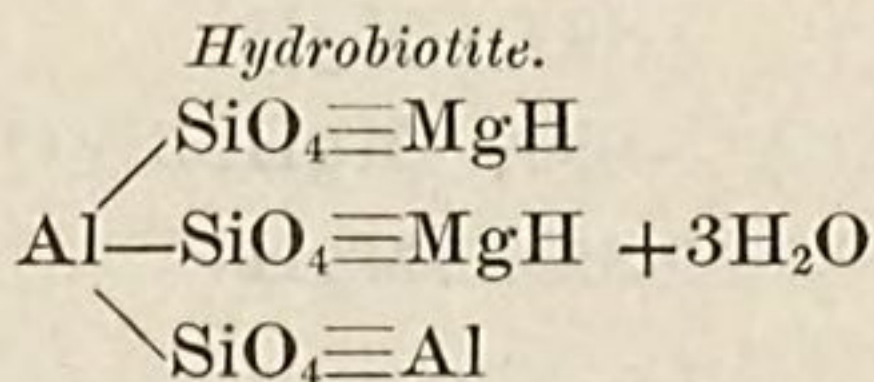
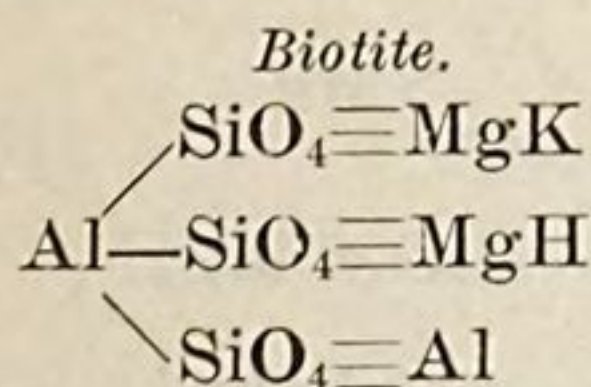


and in detail a mixture of molecules,



The identity of type between cookeite and lepidolite is perfectly clear, and the analogy with the clintonite micas is still more apparent.

In a similar way the other micas alter by hydration, yielding a great variety of products which are known in general as vermiculites. This is especially true as regards the ferromagnesian micas, which lose alkalis and take up water with the greatest ease, in accordance with what seems to be a well-defined law. Thus we have



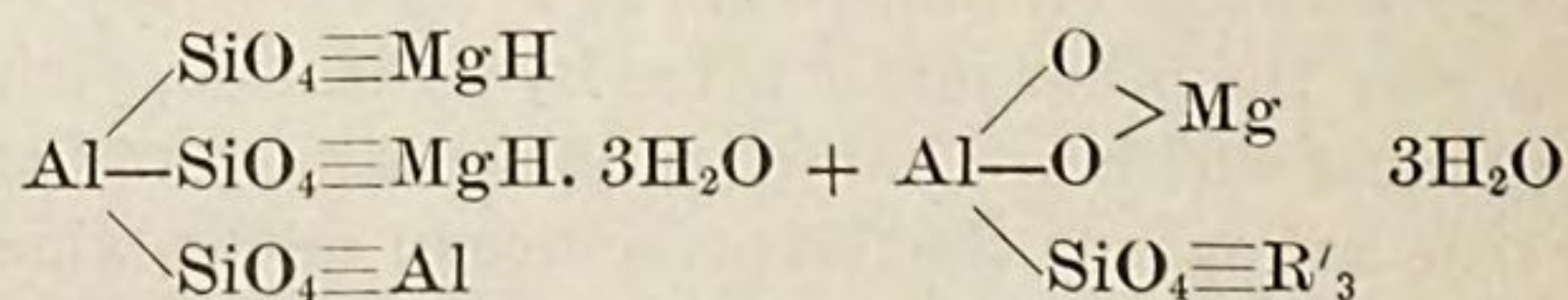
* For fuller discussion, see Bulletin U. S. G. S. No. 113, p. 22.

The micas in question occur in nature in great variety of admixture, and the corresponding vermiculites show a parallel complexity. In every case, however, the alteration of the one series into the other follows the line indicated by the formulæ, and the vermiculite is simply the mica with H in place of K or Na, plus 3 molecules of loosely combined water. Two of these molecules are, as a rule, given off at 100°, and regained in moist air, suggesting an analogy between the vermiculites and the zeolites. Some vermiculites, however, are only monohydrated, and many of the so-called species which have received names are mere mixtures of altered and unaltered micas, representing stages of transition between the original mineral and the final product. Among the more characteristic vermiculites, kerrite, protovermiculite, hallite, and lennilite appear to be essentially trihydrated mixtures of the hydrophlogopite and hydroclintonite types, commingled in ratios nearly as follows:

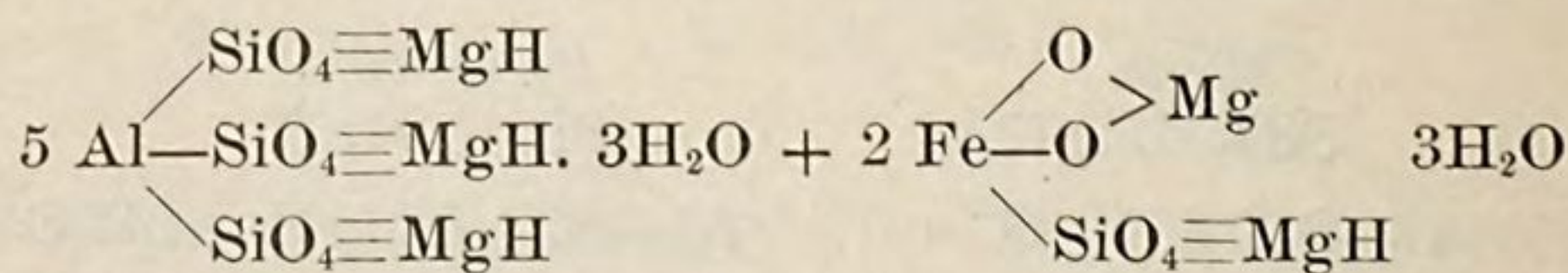
	<i>Hydrophlog.</i>		<i>Hydroclint.</i>
Kerrite.....	5	:	1
Protovermiculite.....	1	:	1
Hallite.....	7	:	18

Lennilite is near hallite, and both may contain small admixtures of chloritic material. The kerrite is quite near the typical hydrophlogopite alone.

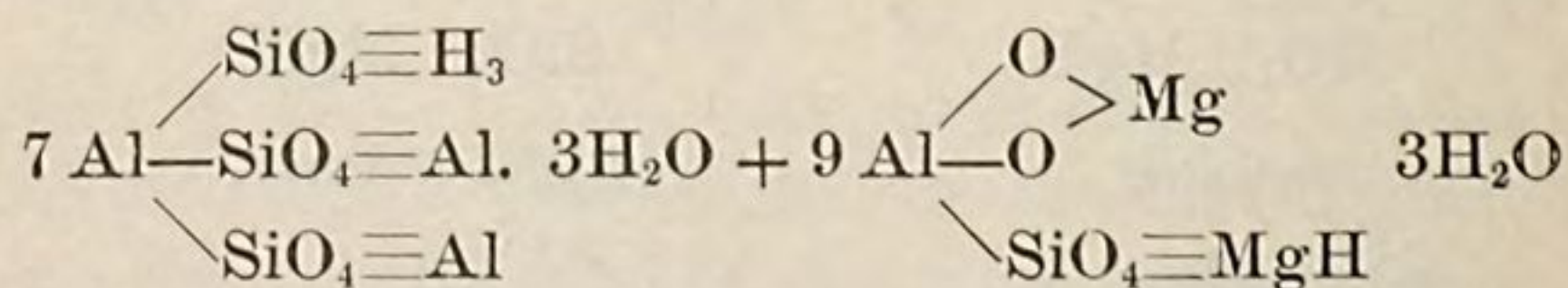
Jefferisite resembles protovermiculite in ratios, but with a hydrobiotite in place of the hydrophlogopite; that is,



and vaalite is very nearly

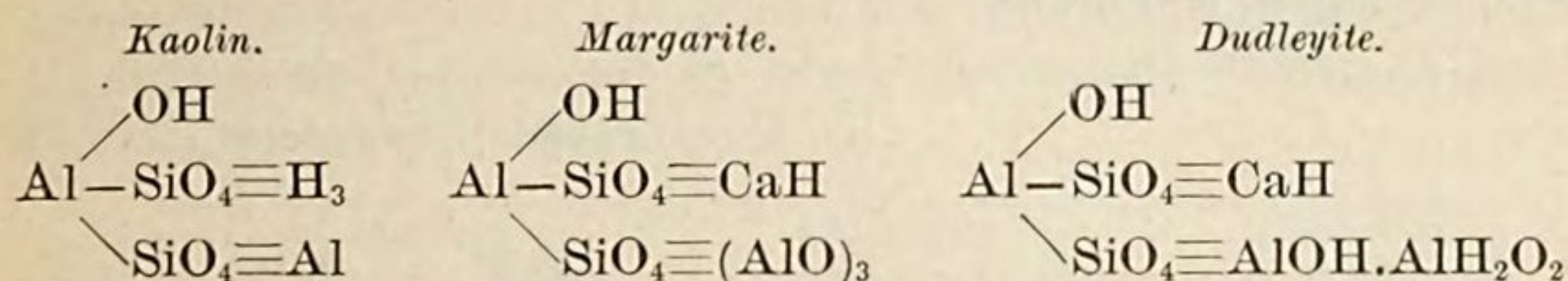


Maconite and lucasite are probably micas which have been partly vermiculitized, and an essential portion of the first-named mineral appears to be a derivative of muscovite. Roseite is very near a mixture of partially muscovitic character, viz:

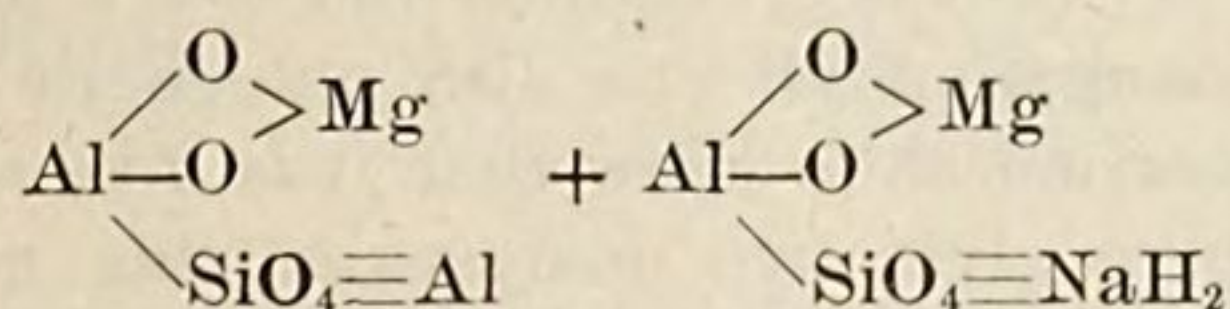


Each of these expressions gives the composition of its respective mineral very closely, and so strengthens the general mica theory. The character of the alteration from a mica is simple, and is what is most reasonably to be expected.

From some points of view, and especially with reference to its crystalline form, kaolin may be regarded as a member of the mica group. As such it would form a connecting link between the micas proper and the clintonite group, and with it the calcium mica, margarite, can be correlated. Furthermore, margarite yields an alteration product, dudleyite, which falls into line with the other two species, thus:



These expressions are suggestive, but not altogether conclusive. They represent the known facts fairly well, however, and can serve their purpose for the time being. Several other micaceous minerals are altogether doubtful in character, and need only passing mention. Thus helvetan may be a trisilicate of the biotite type. Caswellite,* an alteration product of a manganesian biotite, may be written as a member of the clintonite group. Willcoxite seems to be an alkaline clintonite, and corresponds very closely to



There are also several vermiculitic minerals which probably belong in the chlorite group. All of these supposed species need further investigation.

In roscoelite, which is a vanadium mica, the ratios are quite uncertain. According to Genth, the mineral contains V_2O_3 , while Roscoe gives the vanadium as V_2O_5 ; and in other respects the analyses are discordant. If Genth's analysis is accepted, roscoelite has essentially the ratios of a phengitic muscovite, with half of the aluminum replaced by vanadium. This seems to be probable, but the species needs reanalysis.

Ganophyllite, described by Hamberg in 1890,† and regarded by the discoverer as a manganese zeolite, should probably be classed with the micas. Like the micas, it is monoclinic, highly cleaveable, and gives a percussion figure consisting of a six-rayed star. In all its physical characteristics it resembles the micas, with one of which, manganophyll, it is associated. It loses water, however, in vacuo, regaining the amount lost on exposure to moist air, and on this account it may be compared either with the zeolites or with the vermiculite group.

* Chester, Trans. N. Y. Acad. Sci., XIII, p. 97, 1894.

† Geol. Fören. Förhandl., XII, p. 586.

On the latter basis it agrees in composition with a hydrated manganese phlogopite, having the subjoined admixture of molecules:

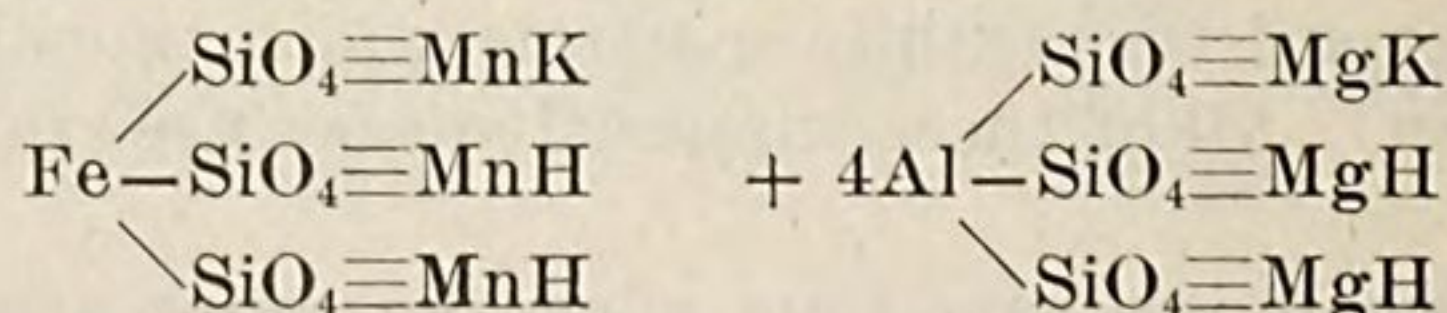
1. $\text{Al}(\text{Si}_3\text{O}_8)_3\text{Mn}_3\text{H}_3.2\text{aq.}$
1. $\text{Al}(\text{SiO}_4)_3\text{Mn}_3\text{H}_3.2\text{aq.}$
2. $\text{Al}(\text{SiO}_4)_3\text{Mn}_3\text{KH}_2.2\text{aq.}$
3. $\text{Al}(\text{SiO}_4)_3\text{Mn}_3\text{NaH}_2.2\text{aq.}$

or, in percentages, as follows:

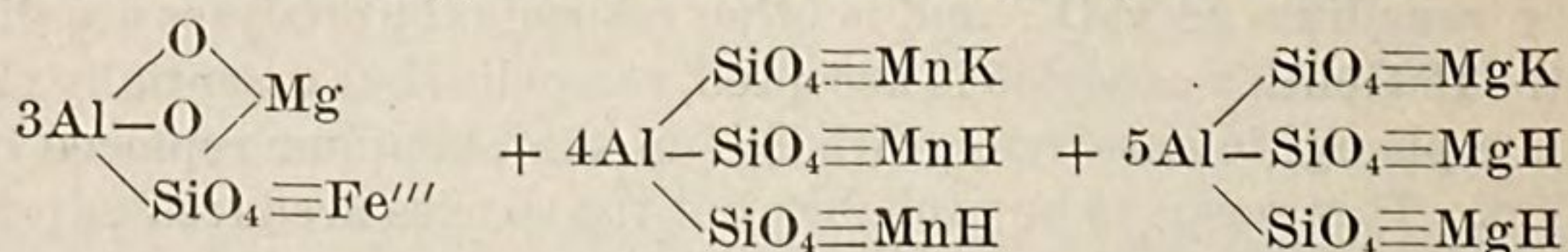
	Found.	Calculated.
SiO_2	39.67	39.99
Al_2O_3	7.95	8.81
Fe_2O_3	.90	
MnO	35.15	36.80
CaO	1.11	
MgO	.20	
PbO	.20	
K_2O	2.70	2.33
Na_2O	2.18	2.29
H_2O	9.79	9.78
	99.85	100.00

Of this water 6.22 per cent is crystalline and 3.56 constitutional.

The associated manganophyll has also phlogopite ratios, but varies so widely in composition as to show that it is, like many other micas, a mixture. Hamberg gives two analyses of this mineral; the first variety, of a reddish-brown color, agrees with



The second variety, which is dark-brown, may be written

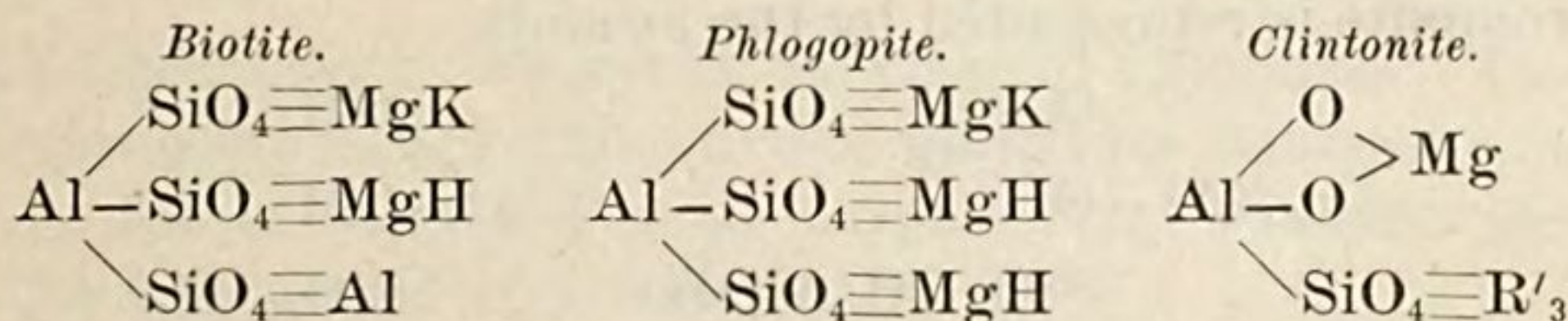


These manganophylls are from Pajsberg, but the manganophyll from Longban, analyzed by Flink, has ratios which indicate the presence of biotitic molecules somewhat similar to those found in alurgite. Manganophyll, however, contains among its constituents a true manganese phlogopite, of which ganophyllite is most probably the hydrate. On this basis both minerals are most easily explained, and all their relations are accounted for.

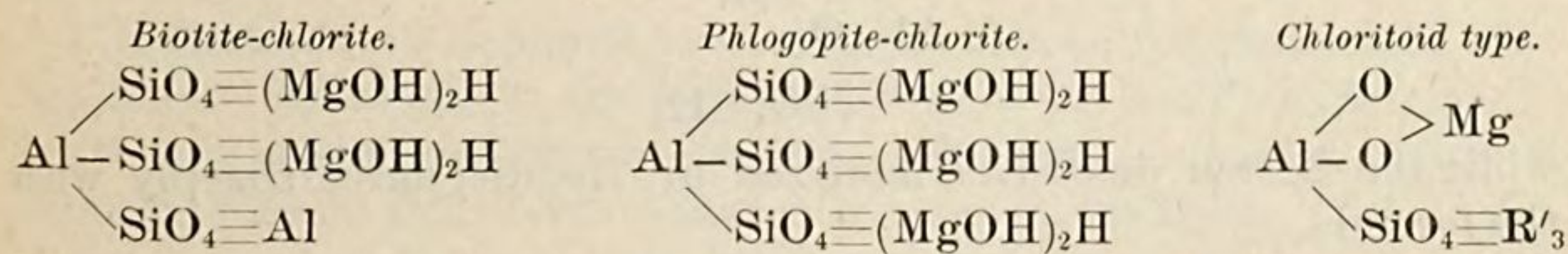
Between the micas and the chlorites the relations are exceedingly close, as regards both composition and physical properties, and from certain points of view the vermiculites are to be regarded as a transitional series connecting the two groups. All the species are highly

foliated, all or nearly all are monoclinic, and to each of the definite ferromagnesian micas a chlorite, higher in magnesia and water, seems to correspond. In former publications* I have sought to show that the chlorites may be interpreted as derived from magnesium orthosilicate in the same way that the micas are derived from the normal aluminum salt; but fuller consideration leads me to a more satisfactory generalization, which unites both series under one set of fundamental formulæ.

Returning to the normal micas and ignoring the replacements of magnesium and aluminum by other equivalent bases, we have the following formulæ already developed:



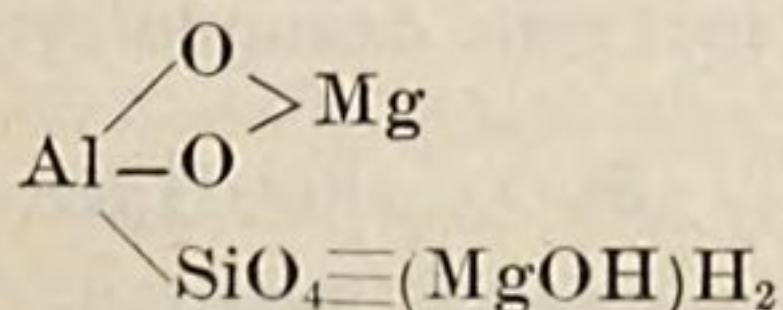
By admixtures of these types all of the ferromagnesian micas are completely explained, and for the orthochlorite series the following parallel expressions are similarly sufficient:



An average pennine consists of the first and second of these types in the ratio 1:1, and an average clinochlore has the same molecules in the ratio 2:1. From these ratios the following composition is deduced:

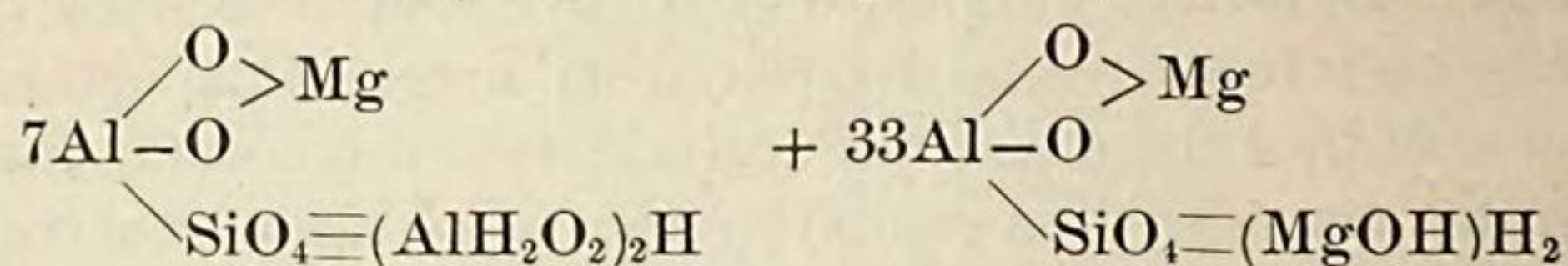
	Pennine.	Clinochlore.
SiO ₂	34.35	34.97
Al ₂ O ₃	14.60	16.51
MgO	38.17	36.27
H ₂ O	12.88	12.25
	100.00	100.00

In both minerals, as among the corresponding micas, admixtures of molecules of the third type occur, giving a range of variation which is shown in the published analyses. Thus, for leuchtenbergite, we have, with the molecules given above, a large admixture of the compound



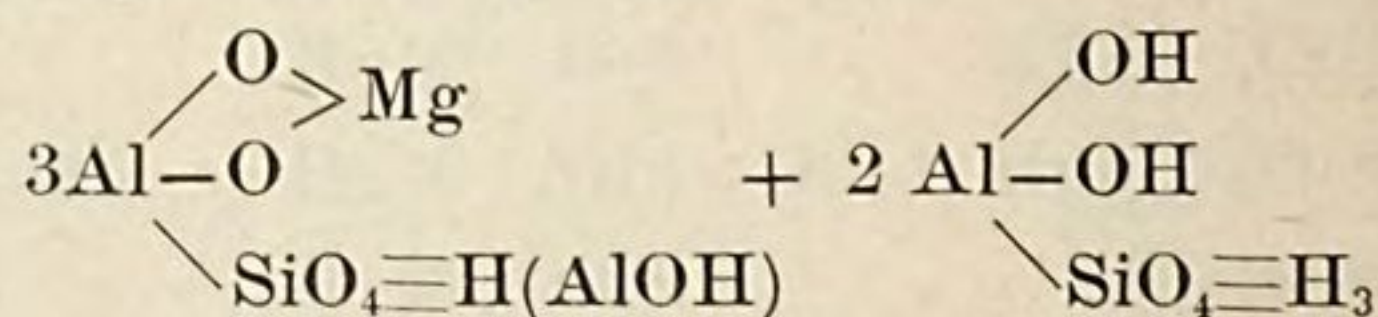
* Bull. U. S. Geol. Survey, No. 78, p. 22; Bull. No. 90, p. 17; Bull. No. 113, pp. 11 and 27.

while in prochlorite and corundophilite the latter compound predominates. Prochlorite has the last formula, with trifling admixtures of chloritoid or ottrelite, and corundophilite agrees with the composition

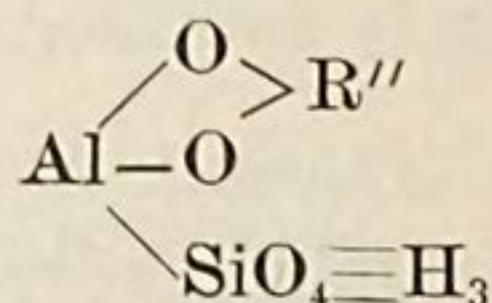


In both prochlorite and corundophilite there are large replacements of magnesium by iron.

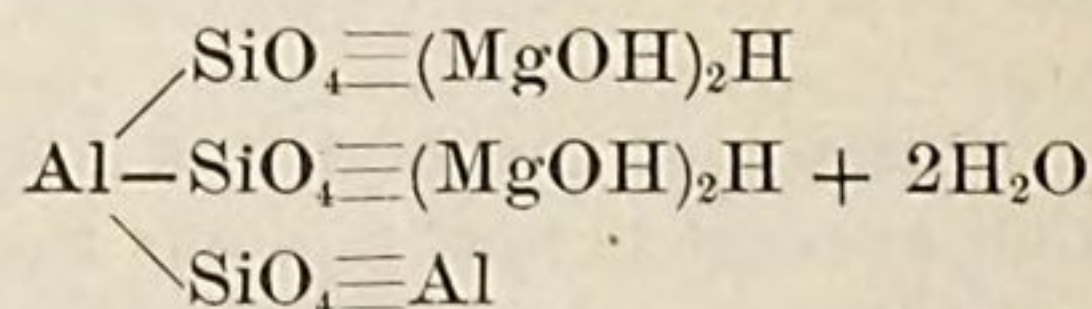
To these formulæ some of the rarer or obscurer chlorites offer interesting variations, which, however, are all simple and intelligible. Thus, rumpfite is represented by the formula



the first compound being a magnesian chloritoid, and the second a molecule already indicated in cookeite. The original delessite is very near

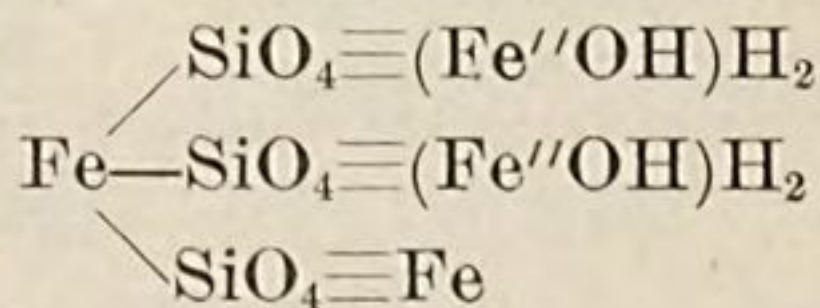


while the Scotch delessites, analyzed by Heddle, agree sharply with the formula

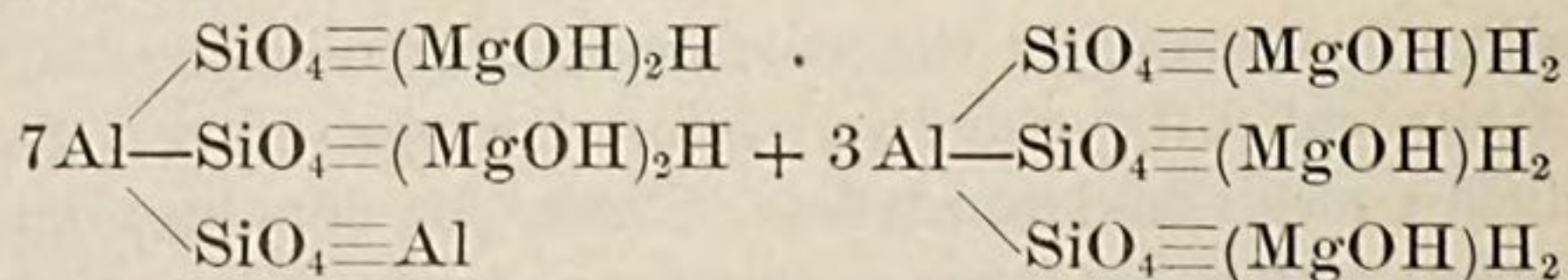


with one-fourth of the Mg replaced by Fe. In the last case the discrimination between hydroxyl and water of crystallization is shown by the analyses, and it is very probable that an analytical revision of the chlorites would bring other instances of the same kind to light.

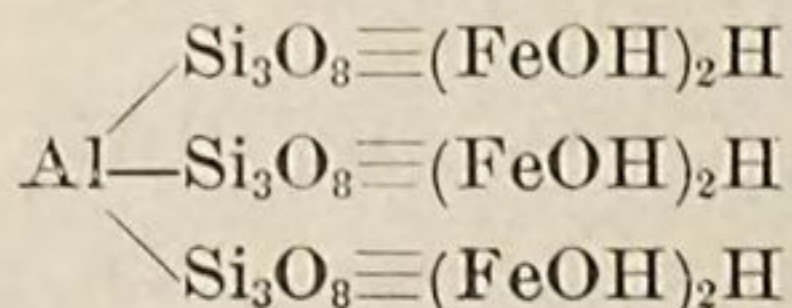
For melanolite we have very closely the composition



and for euralite

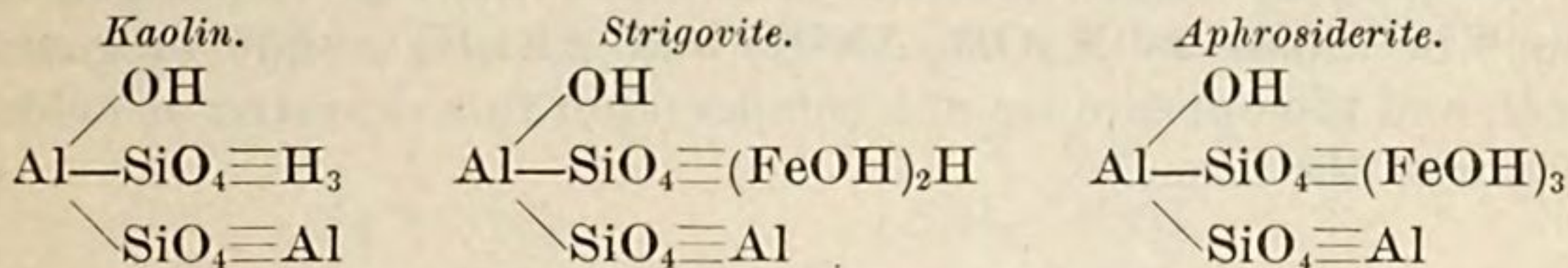


Trisilicate molecules, as among the micas, also appear in the chlorite series, and stilpnomelane is a good example of this kind. Its formula is very nearly

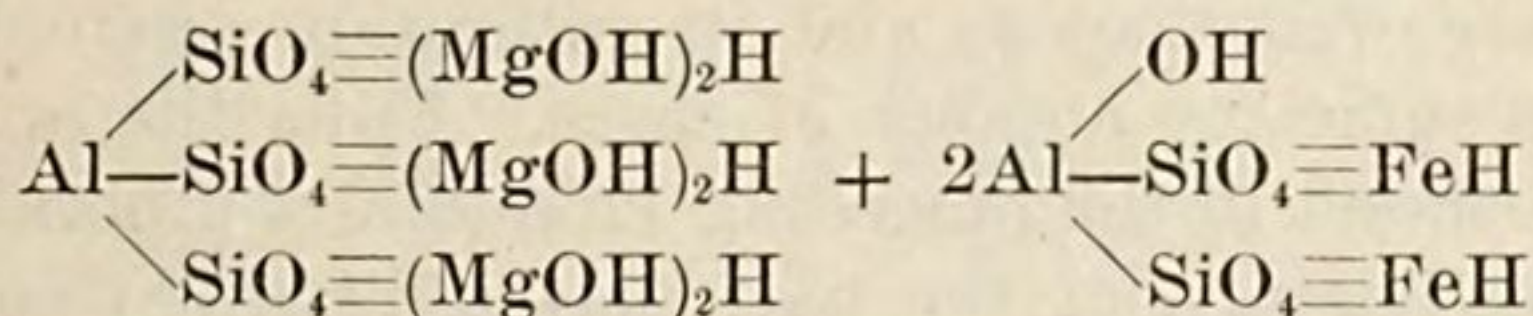


with very little SiO_4 , and epichlorite is a mixture of this salt with the equivalent $\text{Al}(\text{SiO}_4)_3(\text{MgOH})_6\text{H}_3$, the two compounds being commingled in nearly equal percentages, or about half and half.

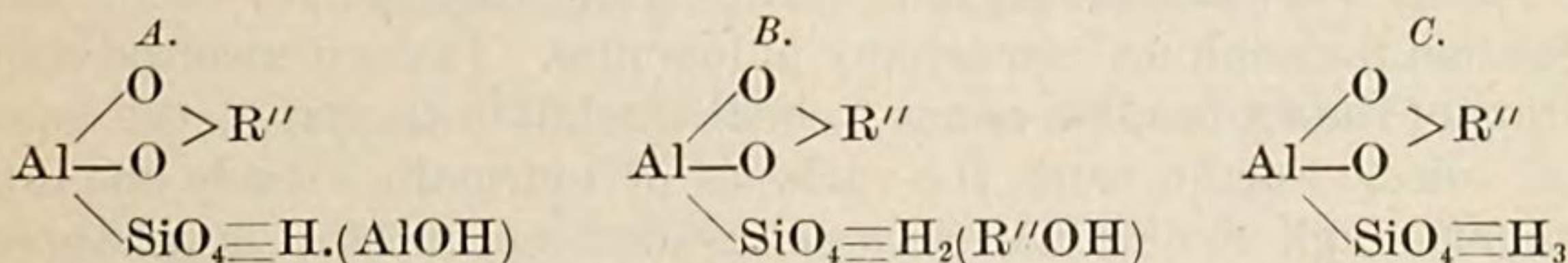
Some of the chlorites, also, are parallel with kaolin and margarite in constitution. Aphrosiderite and strigovite, for example, are well represented, as follows:



with much ferric iron in strigovite in place of aluminum. In diabantite we find a composition indicative of a mixture between a molecule of this type and one in the normal series. The diabantite from Connecticut, for instance, is very near



For the minerals daphnite, metachlorite, klementite, chamoisite, thuringite, and cronstedtite, the formulæ are more or less doubtful, for the reason that alternatives are possible. They all, however, reduce to mixtures of the chloritoid or clintonite type, of the forms



Using the letters underneath the formulæ as symbols, the several species become

Chamoisite.....	B_1C_1 , with all $\text{R}'' = \text{Fe}$
Metachlorite.....	B_3C_1 , with all $\text{R}'' = \text{Fe}$
Thuringite.....	$\text{A}_1\text{B}_1\text{C}_1$, with all $\text{R}'' = \text{Fe}$
Klementite.....	$\text{A}_1\text{B}_2\text{C}_1$, with R'' mostly Mg
Daphnite.....	$\text{A}_1\text{B}_5\text{C}_4$, with R'' mostly Fe

In cronstedtite there is a range from $\text{A}_1\text{B}_1\text{C}_1$, as in thuringite, to A_1B_2 , and all the aluminum is replaced by ferric iron, while all $\text{R}'' = \text{Fe}$. These expressions give the composition of the several species very closely, and serve to correlate them with delessite, rumpfite, prochlorite, and corundophilite. All of the valid evidence is satisfied, and the micas, clintonites, vermiculites, and chlorites form one systematic group. The facts that garnet and vesuvianite alter into chlorites, and that chloritic pseudomorphs after feldspar are known, serve to still more closely connect the formulæ here adopted with the similar formulæ of the preceding groups of minerals.

When clinochlore or leuchtenbergite is strongly ignited, it yields, like xanthophyllite, a product insoluble in hydrochloric acid, having the composition of spinel. This reaction establishes still more definitely the relationship between the chlorites and the clintonite group, and it is readily intelligible in the light of the structural expressions. The splitting up, under influence of heat, of mixtures containing such groups of atoms as MgOH , AlOH , and AlO_2H_2 , ought to generate spinel, and the appearance of a compound of this character is evidence in favor of the formulæ.

VI. THE TOURMALINE GROUP.

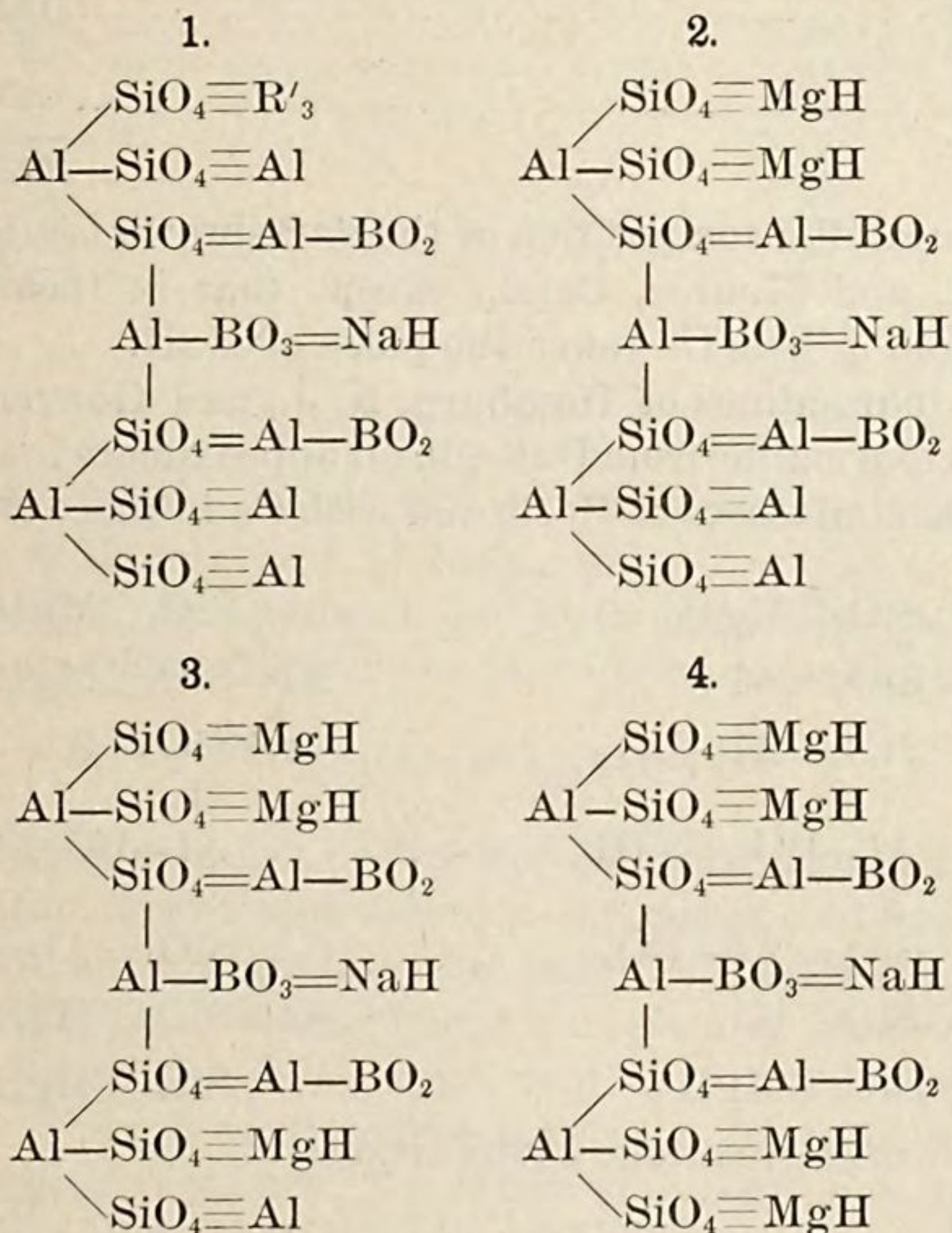
Although tourmaline, in its several varieties, is apparently quite complex, the evidence for its interpretation is abundant and ample. Its variations in composition are shown by numerous good analyses, its associations are well known, and its alteration products have been observed in a sufficient number of cases. From the minerals which have been discussed in the preceding chapters, it differs essentially in that it contains boron, and the part played by this element is a new question to be interpreted.

When tourmaline undergoes alteration, the commonest product is a mica, and between the micas and the tourmalines there are very striking analogies. With the lithia micas, lithia tourmalines are generally associated; with muscovite and biotite, iron tourmalines occur, and magnesian tourmalines accompany phlogopite. In each case the composition of the tourmaline seems to bear a relation to that of the associated mica. Furthermore, the varieties of tourmaline shade one into another through an unbroken series of gradations, and this may happen to some extent in one and the same crystal. The genus tourmaline, in short, represents a series of compounds, and these are parallel to the normal mica series. These considerations lead directly to a system of formulæ, which, like those of the micas, are derivable from molecules of the normal aluminum orthosilicate, and which express completely all the known chemical relations of tourmaline.

On studying carefully all the more recent and more trustworthy analyses of tourmaline, a constant ratio appears connecting silicon, boron, and oxygen, which is represented by the figures $\text{Si}_6\text{B}_3\text{O}_{31}$. The variations from constancy are almost all within the limits of accuracy of the analyses, but occasionally a small amount of fluorine is noted, which appears to replace the univalent acid group BO_2 . Aluminum, with respect to silicon, varies widely, the ratio ranging from Al_3Si_6 to Al_5Si_6 , while the other bases vary reciprocally with aluminum and in the opposite direction. The tourmalines high in aluminum approach, like muscovite, most nearly to the normal ortho-salt; those lowest in aluminum are high in magnesium, like phlogopite; and, like biotite in the mica group, the iron tourmalines lie between these extremes.

Taking now the smallest amount of aluminum found in the formula of any tourmaline, all varieties of the species may be regarded as containing the nucleus $\text{Al}_5(\text{SiO}_4)_6(\text{BO}_3)(\text{BO}_2)_2$, in which 14 units of affinity are still unsatisfied, and among which all of the essential variations in composition take place. The orthoboric group, BO_3 , is obviously trivalent, BO_2 being univalent, and the radicle of metaboric acid.

From this nucleus four types of tourmaline are derivable, thus:



and to all of these, known varieties of the mineral correspond. The only notable variations are due to Cr or Fe replacing Al, Fe or Mn replacing Mg, small quantities of F replacing BO_2 , and in No. 4, Ca sometimes replacing NaH. If in No. 1 $\text{R}'_3 = \text{LiH}_2$, and in No. 2 Fe_2 replaces Mg_2 , these formulæ give the subjoined percentage compositions:

	1	2
SiO_2	38.05	35.16
B_2O_3	11.10	10.25
Al_2O_3	43.13	34.86
FeO} .....	.....	14.06
Na_2O	3.28	3.03
Li_2O	1.58	.....
H_2O	2.86	2.64
	100.00	100.00

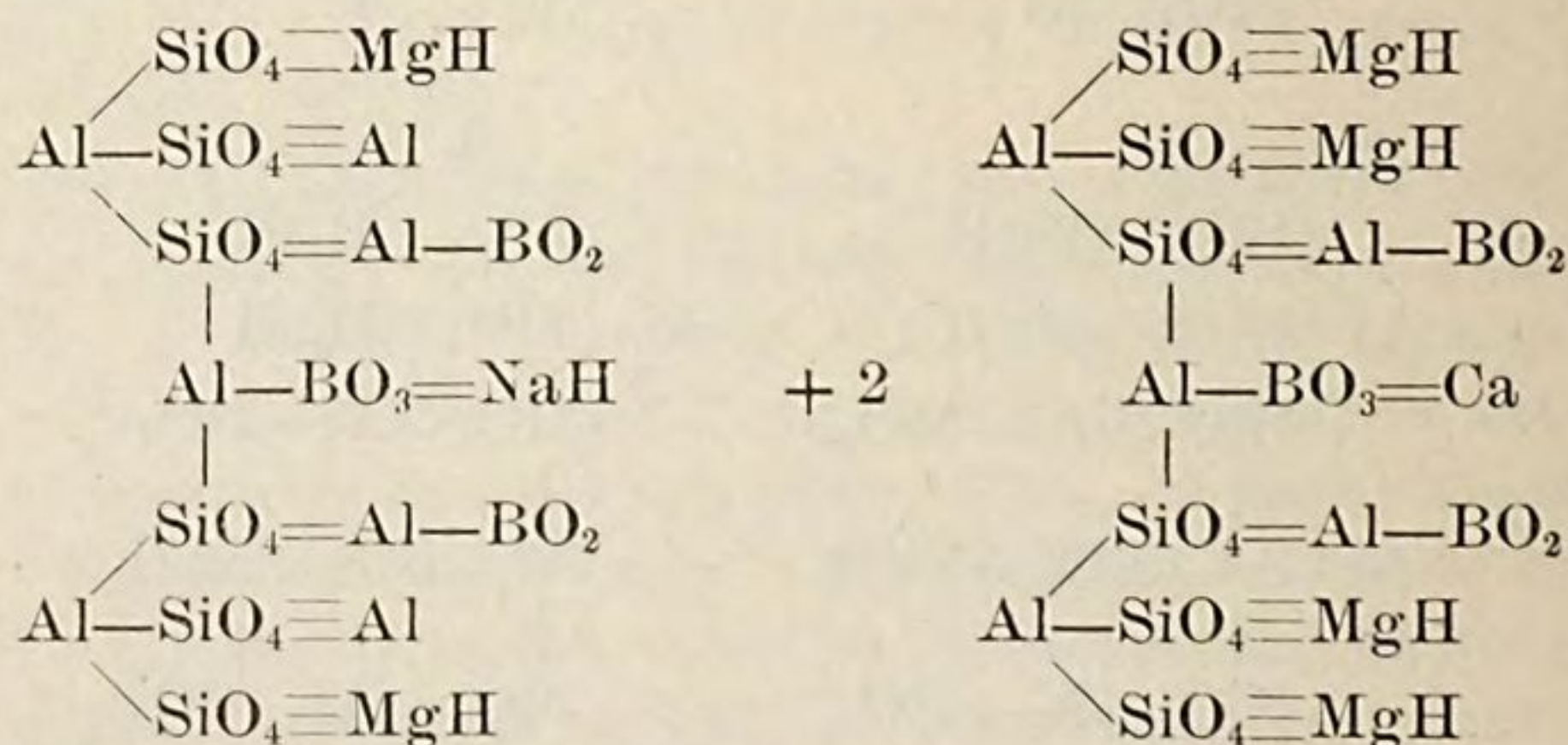
These figures agree well with the best analyses of the lithia tourmalines and the ordinary black tourmalines which are found in the same localities; divergencies being due to trifling admixtures of one with the other, and to the presence of fluorine as previously noted.

Formula No. 3 corresponds to

SiO ₂	37.58
B ₂ O ₃	10.96
Al ₂ O ₃	31.94
MgO	12.52
Na ₂ O	3.24
H ₂ O	3.76
	100.00

which is very near the composition of the dark-brown tourmalines from Orford, N. H., and Monroe, Conn., except that in them a little Fe replaces Mg, and a little Ca takes the place of NaH.

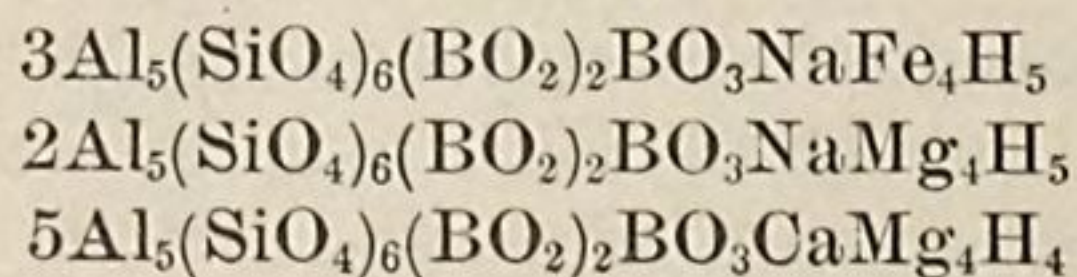
The brown tourmalines of Hamburg, N. J., and Gouverneur, N. Y., with the white tourmaline from DeKalb; all approximate toward formula No. 4, but with admixtures of No. 3, and with Ca in place of NaH. The mixture



gives the following percentage composition:

SiO ₂	37.19
B ₂ O ₃	10.85
Al ₂ O ₃	29.86
MgO	13.77
CaO	3.86
Na ₂ O	1.06
H ₂ O	3.41
	100.00

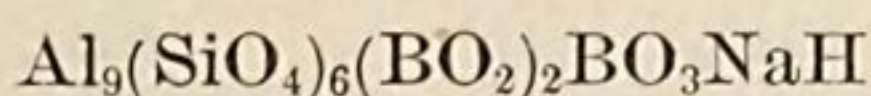
which represents the DeKalb tourmaline fairly well. In the Hamburg mineral there is more of the calcium compound, and in that from Gouverneur rather less. The black tourmaline from Pierrepont gives formula No. 4 very closely, except that about three-tenths of the Mg has been replaced by Fe, and one-half of the NaH by Ca. Calculating for the following mixture of molecules:



we have the following comparison with Riggs's analysis of Pierrepont tourmaline:

	Found.	Calculated.
SiO ₂	35.61	} 35.91
TiO ₂	.55	}
B ₂ O ₃	10.15	} 10.48
F.....	.27	}
Al ₂ O ₃	25.29	} 25.44
Fe ₂ O ₃	.44	}
FeO.....	8.19	8.62
MgO.....	11.07	11.17
CaO.....	3.31	2.79
Na ₂ O.....	1.51	} 1.55
K ₂ O.....	.20	}
H ₂ O.....	3.34	4.04
	99.93	100.00

Tourmalines which do not correspond to any one of the four types given agree with mixtures of them, and all of the analyses of this mineral published by Jannasch and Calb or by Riggs can be reduced to suitable formulæ. These formulæ suggest an end product,



which may possibly exist, but is not known. They also indicate the obvious relationship of tourmaline to the micas, and express the ready alterability of the former into the latter. A molecule of tourmaline, with elimination of boric acid and one atom of aluminum, splits into two molecules of the mica type, and the transformation is easily understood. Potash is of course taken up. Certain experiments by Lemberg,* who investigated the action of alkaline solutions upon tourmaline, are in accord with these suppositions.

Although otherwise interpreted by Brögger, the minerals cappelinite, melanocerite, karyocerite, and tritomite seem to be structurally akin to tourmaline. This view of their nature has already been suggested by Wiik,† and it is sustained both by chemical and by morphological considerations. Cappelinite is hexagonal, and the other species, like tourmaline, are rhombohedral. They are silicates of rare earths, which are mostly trivalent, like aluminum; all contain boron, and all but cappelinite contain fluorine also. Furthermore, all four species, considered together, illustrate the reciprocity between boric acid and fluorine, which has been suggested in the discussion of tourmaline.

* Zeitsch. Deutsch. Geol. Gesell., 1892, p. 239.

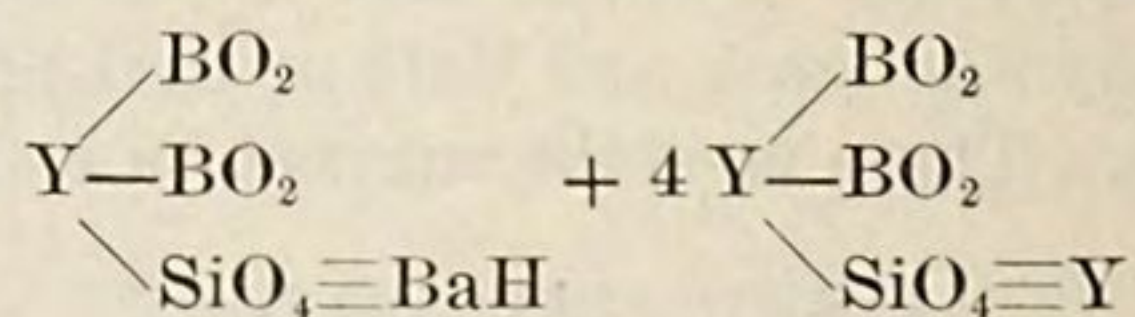
† Zeitsch. Kryst. Min., XXIII, pp. 421, 422, 1894.

Thus, if we compute the atomic ratios from the analyses cited by Brögger,* the following relation appears:

	Si.	B.	F.	B + F.
Cappelinite	236	488	-----	488
Melanocerite	218	92	304	396
Karyocerite	216	134	296	430
Tritomite	226	210	226	436

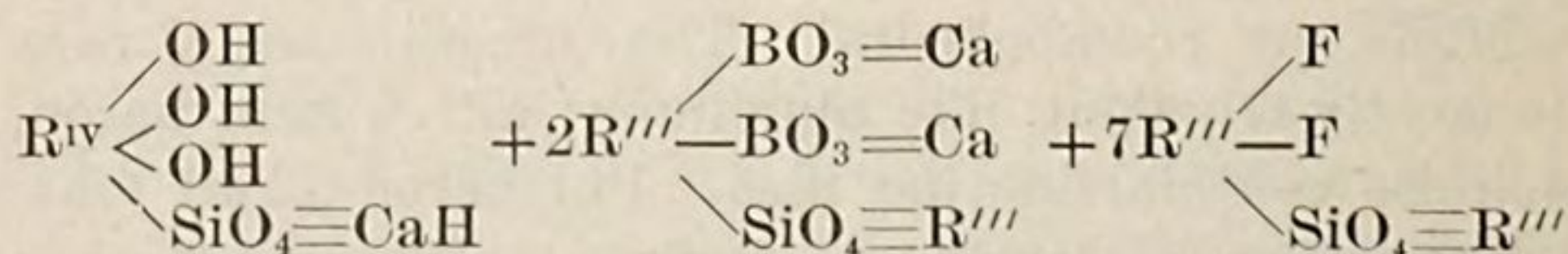
That is, Si:B + F::1:2 nearly, variations being due to the fact that in the first three minerals the boric acid was determined by difference, and also, probably, to the occasional replacement of fluorine by hydroxyl. Another source of variation is found in the presence of tetrad bases, as will be seen later; but for the moment the relation indicated seems to be reasonably clear.

The first member of the group, cappelinite, is a borosilicate of yttrium and barium, and approximates in composition to

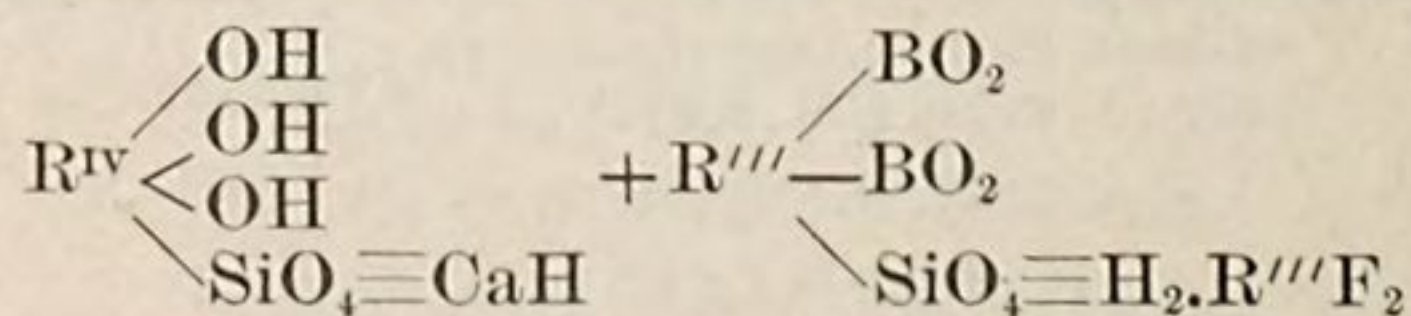


With the earths of uncertain molecular weight designated as "yttria," are a little lanthanum oxide and trifling quantities of ThO₂ and CeO₂, and with the barium are some calcium and alkalies.

The other three members of the group are all more complicated than cappelinite, and vary from it in type by containing tetrad oxides, such as CeO₂, ThO₂, and ZrO₂. In eudialyte and catapleiite we have two rhombohedral silicates of zirconia, which help to explain these compounds. Catapleiite probably has the constitution (OH)₃Zr.Si₃O₈.R'₃. If we regard the tetrad bases in the cappelinite group as forming orthosilicates of this same type, the remainder of each mineral may be written as a mixture of molecules like those already designated, but with cerium earths predominating over yttrium, and fluorine replacing some boric radicles. Thus, melanocerite is not far from



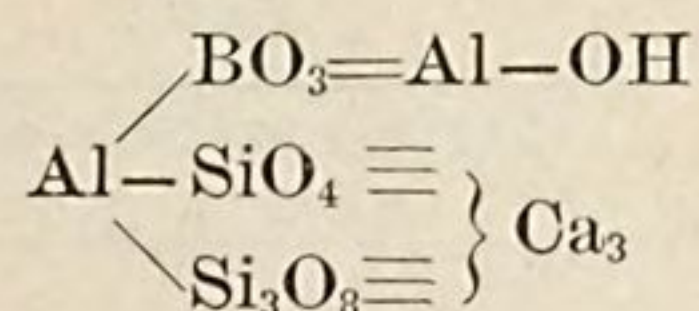
Karyocerite may be written similarly, and tritomite becomes



* Zeit. Kryst. Mm., XVI, pp. 462-469.

These formulæ are uncertain, and need verification with material from other sources. At present they have only a reasonable probability. The tetrad silicate in them, however, will be seen to be highly probable when we come to the discussion of the other allied compounds in their proper connection later.

There is one other borosilicate containing aluminum, axinite, whose relations are uncertain. Physically it differs widely from tourmaline, being triclinic, but on account of its composition it may fairly be considered here. The analyses of it vary to a considerable extent, partly because of uncertainty in the determinations of water and boron, but also in other respects which indicate a mixture of molecules. Some analyses give orthosilicate ratios, provided that the boron is regarded as basic and equivalent to aluminum, but others show much too little oxygen. Boron, however, is essentially an acid-forming element, and it seems more probable that in axinite it has acid functions. The most typical axinite is that from Bourg d'Oisans, and of this the best analysis is by Jannasch and Locke.* From this the following formula is easily derived:

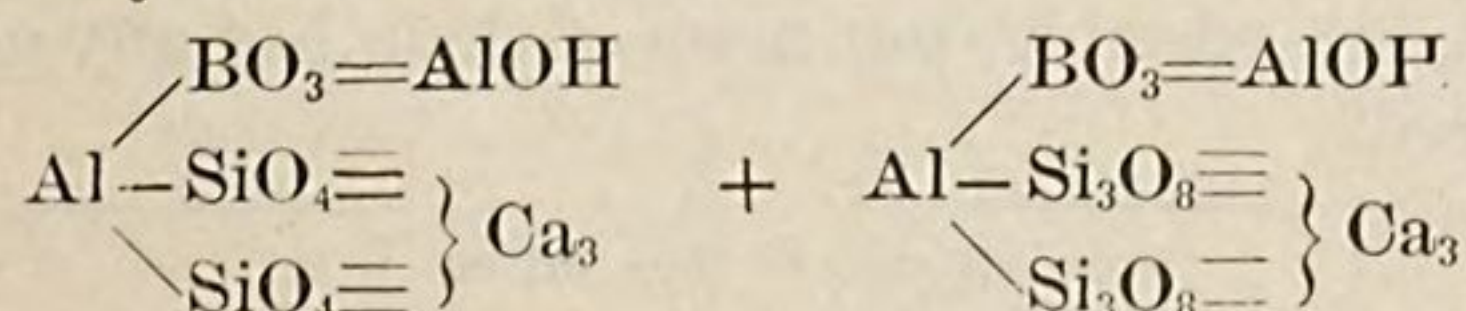


in which the boron is regarded as part of an orthoborate molecule, derived from the acid H_3BO_3 .

This may be compared with Jannasch and Locke's analysis directly, and with the latter reduced by recalculating Fe_2O_3 into Al_2O_3 , the other bases all into their equivalents in CaO , and then bringing to 100 per cent, thus:

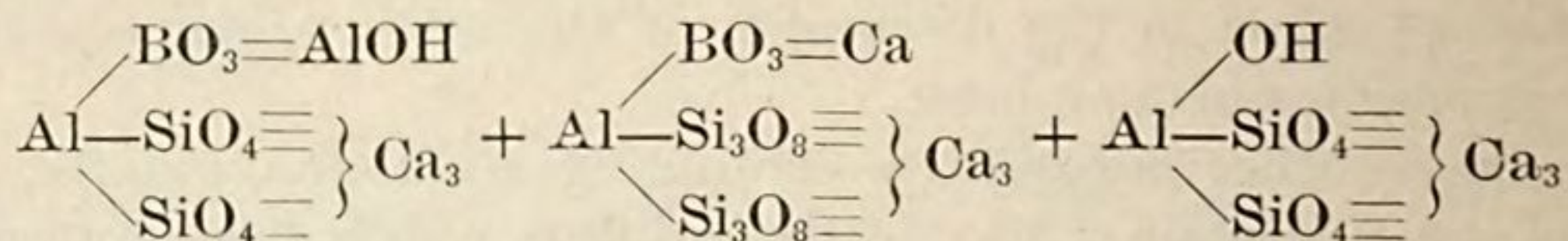
	Found.	Reduced.	Calculated.
SiO_2	42.88	43.13	43.32
B_2O_3	6.02	6.06	6.32
Al_2O_3	18.24	18.73	18.41
Fe_2O_3	.62	}	
FeO	7.10		
MnO	1.06		
CaO	19.89		
MgO	2.23		
K_2O	.11	}	30.33
Na_2O	.36		
H_2O	2.14		
	100.65	100.00	100.00

The formula may also be written



* Zeitsch. Anorgan. Chem., VI, p. 57, 1894.

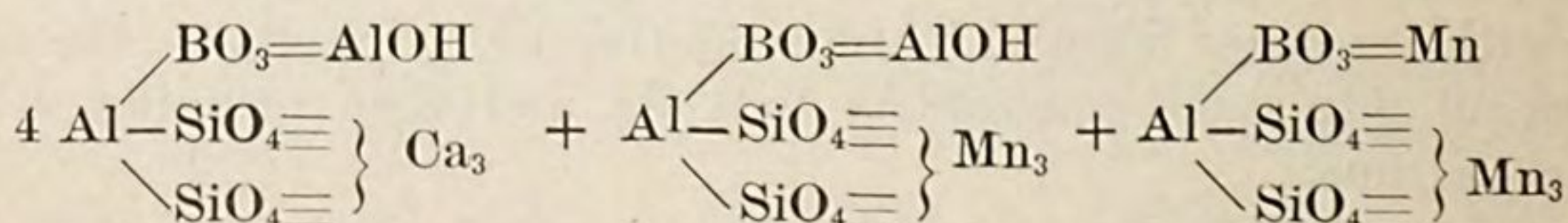
in which form it compares better with other analyses. Thus Baumert's analysis of axinite from the Radauthal* gives



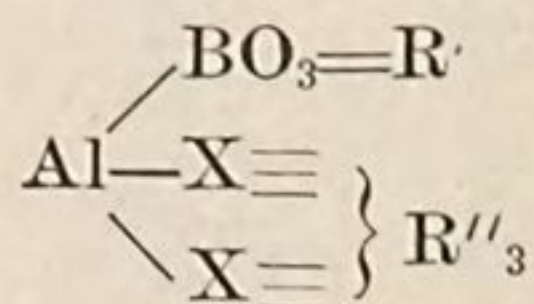
and a comparison as follows:

	Found.	Reduced.	Calculated.
SiO ₂	40.76	40.92	41.32
B ₂ O ₃	4.76	4.78	4.82
Al ₂ O ₃	12.47	13.91	14.05
Fe ₂ O ₃	2.17		
FeO.....	3.60		
MnO.....	2.84	39.17	38.57
CaO.....	30.21		
MgO.....	2.00		
H ₂ O.....	1.22	1.22	1.24
	100.03	100.00	100.00

Genth's analyses* of the axinite from Franklin, N. J., give similar ratios, minus the boron-free molecule required in Baumert's case. Approximately they give



with rather less than half the SiO₄ replaced by Si₃O₈. In general, when $X=\text{Si}_3\text{O}_8+\text{SiO}_4$ all axinite except that analyzed by Baumert gives the general formula



in which R'' is partly AlOH, with Ca, Mg, Mn, or Fe. Until further evidence is available this expression may be regarded as valid, but it represents only the composition of the mineral, and no other relations. It is, however, in conformity with the general theory of substitution. Other formulæ, which represent axinite either as metasilicate or as orthosilicate, are possible, but none of them has any advantage over the one proposed.

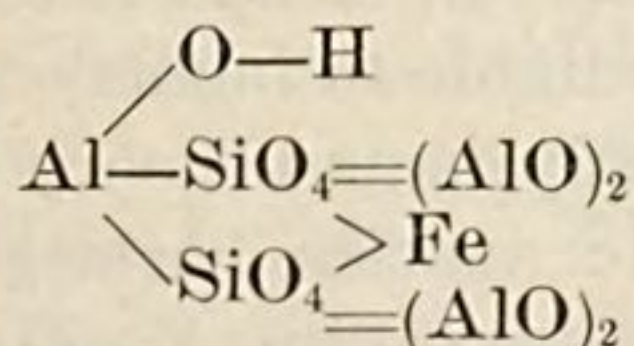
* Dana's System of Min., 6th ed., p. 529.

VII. MISCELLANEOUS SPECIES.

Among the ortho- and trisilicates of aluminum, ferric iron, and other triad elements, there are a considerable number which do not fall conveniently into any of the preceding groups of minerals, or which are doubtful as regards their genetic affinities. Some of them have obvious relationships to other species, and some are quite obscure in character, but all seem to be conformable to the theory of substitution.

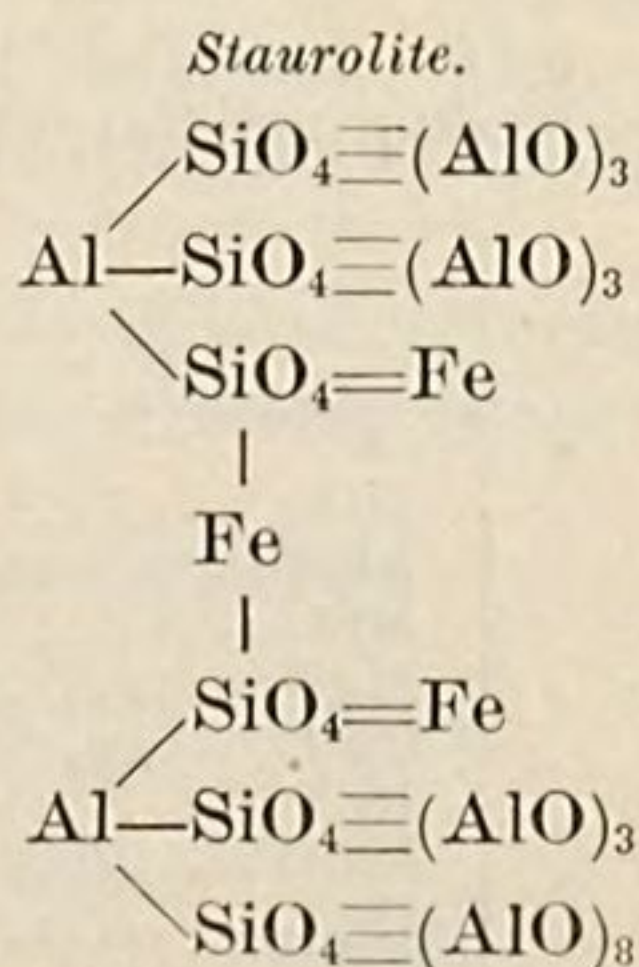
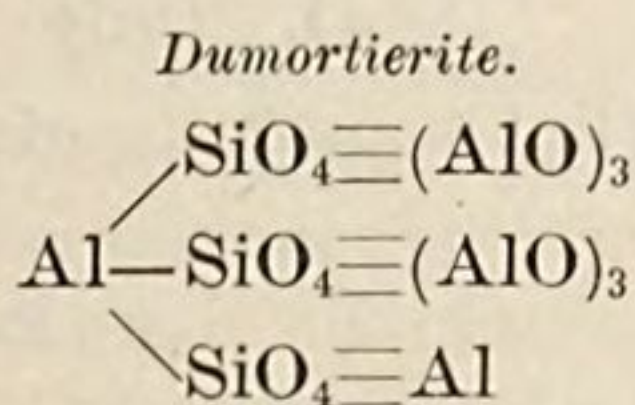
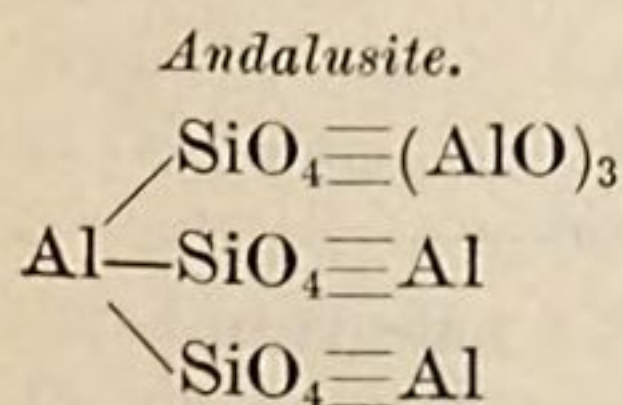
First in order of importance is the mineral staurolite, a highly basic silicate, which is evidently akin to andalusite, dumortierite, and sillimanite, and which, like them, is orthorhombic. Like andalusite, furthermore, staurolite alters into muscovite, an entire crystal becoming transformed throughout into an aggregate of mica scales.

By far the best evidence as to the composition of staurolite is that furnished by the analyses of Penfield and Pratt,* who adopt Groth's formula $\text{HAl}_5\text{Fe}''\text{Si}_2\text{O}_{13}$. This, structurally, is best written



which expresses a partial relation to the micas, andalusite, and so on. The theoretical percentage composition calculated from this formula agrees well with the results of analysis, except that it gives the silica nearly one per cent too low, a discrepancy which Penfield and Pratt attribute to inclusions of silica in the minerals analyzed.

By means of a slightly different formula the relations of staurolite to the other species can be much more clearly shown, but it assumes that the ideal staurolite is not yet known. The expressions proposed are as follows:



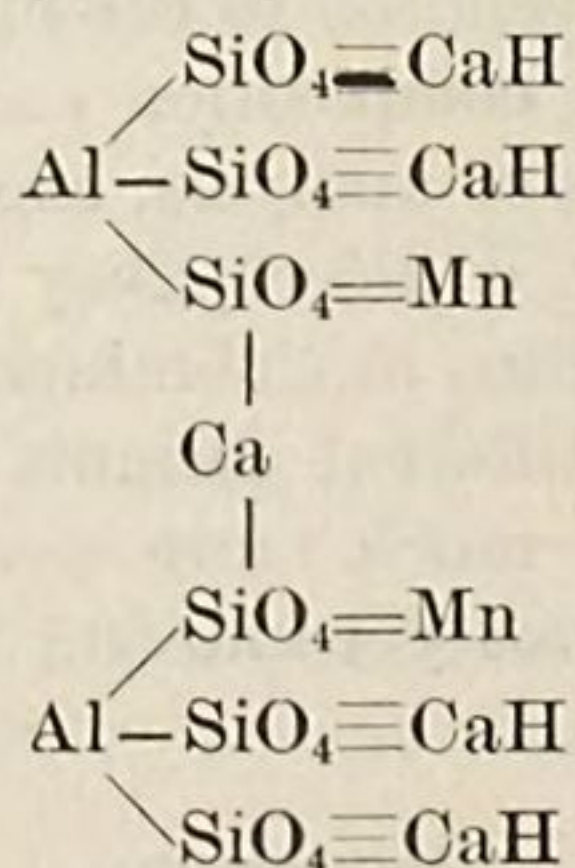
* Am. Jour. Sci., (3) XLVII, p. 81, 1894.

This formula, in contrast with that of Penfield and Pratt, and with their reduced analysis of staurolite from Lisbon, N. H., gives the subjoined percentage composition:

	Lisbon.	P. and P.	New formula.
SiO ₂	27.44	26.32	27.90
Al ₂ O ₃	55.16	55.92	55.35
FeO	15.72	15.79	16.75
H ₂ O	1.68	1.97	.....
	100.00	100.00	100.00

If, now, we assume that the actual staurolite is slightly altered by hydration, some Fe being replaced by H₂ and by FeOH+H, the discrepancies between formula and analyses are sufficiently accounted for. The new formula is more symmetrical than the old one; it better expresses the alterability of staurolite into muscovite, and it seems to satisfy the evidence with sufficient completeness. When we remember that staurolite is excessively liable to inclusions and alterations, a very sharp agreement between analysis and theory is not to be expected.

Still another orthorhombic species, harstigitite, has a formula analogous in some ways to that of staurolite. For harstigitite there is but one analysis extant, which gives, nearly

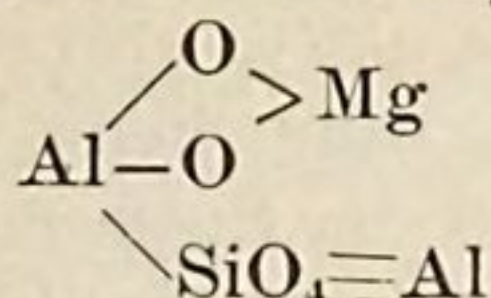


This, in comparison with Flink's analysis, gives

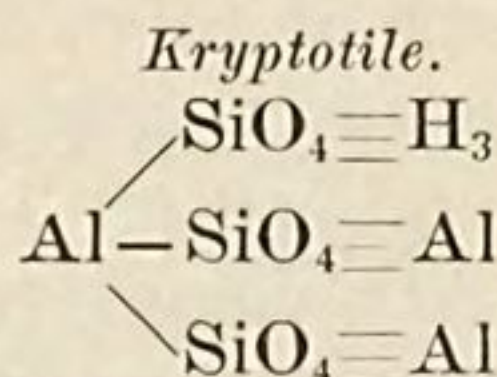
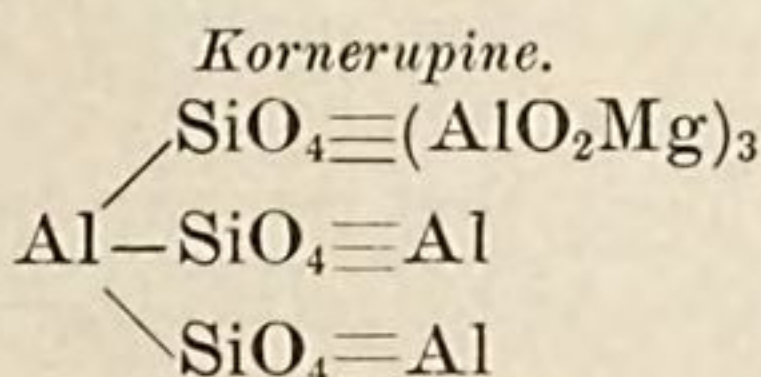
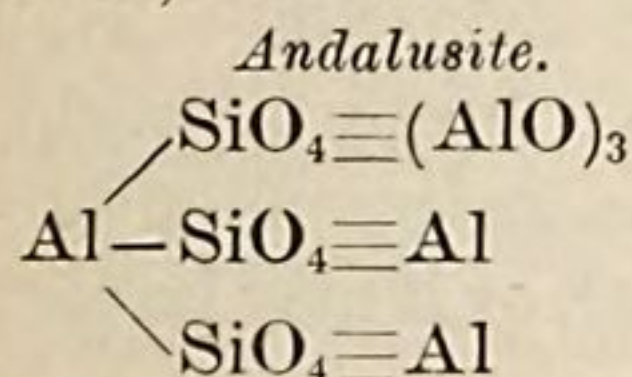
	Found.	Calculated.
SiO ₂	38.94	39.13
Al ₂ O ₃	10.61	11.09
MnO	12.81	} 15.43
MgO	3.27	
CaO	29.23	
K ₂ O	.35	
Na ₂ O	.71	} 30.44
H ₂ O	3.97	
	99.89	100.00

a result which is fairly satisfactory. More data relative to harstigitite are evidently needed.

In order to interpret the clintonite micas, the highly basic compound



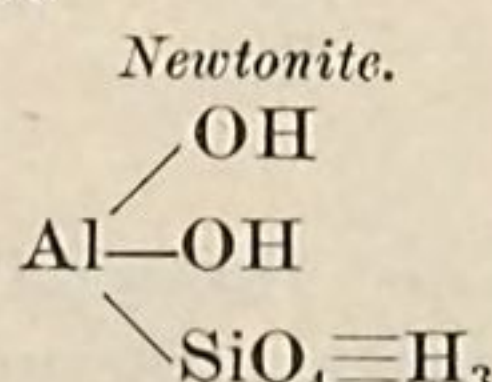
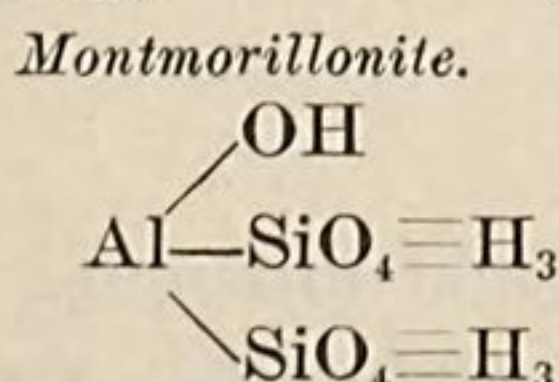
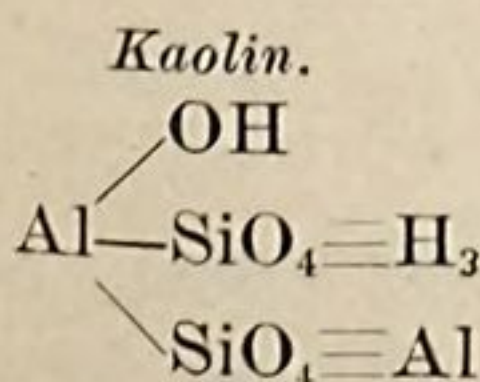
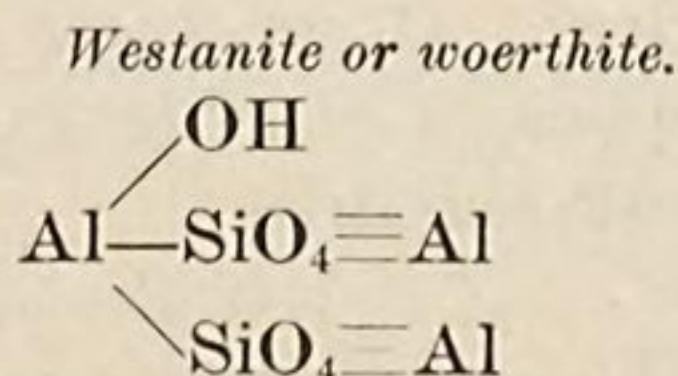
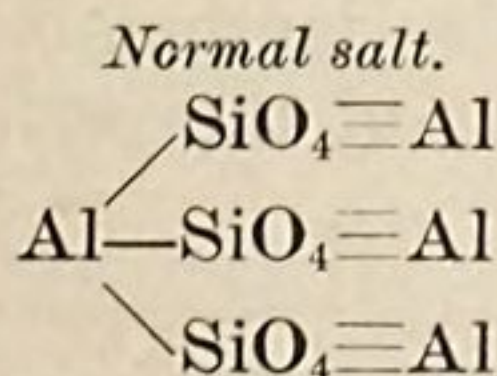
was assumed. This formula also gives, empirically, the percentage composition of the species kornerupine or prismatine, which, unlike the micas, is orthorhombic, and also insoluble in acids. On these grounds it may be compared with andalusite and staurolite; and a clew to its constitution is found in the existence of an alteration product of prismatine, kryptotile, having the composition HAlSiO_4 . Tripling the formulæ, we have



symbols which express the observed relationship between these and other species. Further than this the formulæ have no real significance, and alternative expressions are considered later in connection with the pyroxenes and amphiboles. Associated with kornerupine the still more basic sapphirine, $\text{Mg}_5\text{Al}_{12}\text{Si}_2\text{O}_{27}$, is found. To the constitution of this species there is no good clew, and any attempt at structural formulation is useless. More than one structural formula is possible for sapphirine, but all are at present meaningless, except in so far as they show that the compound is stoichiometrically conceivable.

A peculiarly difficult group of minerals to interpret constitutionally is the group of clays. One member of this group, kaolin, has already been considered, and this member has the advantage of being crystalline. The other clays are amorphous, and of uncertain origin; they often occur in complicated mixtures, are difficult to identify with certainty, and still more difficult to correlate with other species. They represent undoubtedly the breaking down of crystalline silicates, to which they are related somewhat as kaolin is related to the feldspars; but rarely, if ever, has their actual genesis been observed. Their formulæ, therefore, are merely tentative, and serve only as a first step toward a better study of the several species.

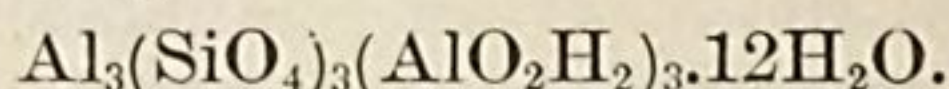
Upon comparing the formula of aluminum orthosilicate with that of kaolin, an indication of serial arrangement becomes evident, which may be written thus:



Woerthite is an altered sillimanite, and westanite is perhaps a similar derivative of andalusite. The newtonite compound has already appeared in the mica series among the components of cookeite and rumpfite.

The best that can be said for these formulæ is that they are suggestive. In one respect they are highly questionable, for the reason that the group $-\text{SiO}_4 \equiv \text{H}_3$ is indicative of loosely combined water, while in these particular clays the water is quite firmly retained. On this point much fuller information is needed, and future evidence may prove that the serial relation indicated is apparent only.

The composition of rectorite may be $\text{Al}_3(\text{SiO}_4)_3\text{H}_3 + 2\text{H}_2\text{O}$, or that of a hydrous kryptotile. Halloysite has the composition of kaolin plus one molecule of water, the latter being removable at or about 100° . Halloysite, however, differs from kaolin in being decomposable by hydrochloric acid, and hence it is unlikely that the two species have similar structure. Allophane is perhaps $(\text{AlO}_2\text{H}_2)_2\text{H}_2\text{SiO}_4 + 3\text{H}_2\text{O}$, or it may be written analogously to andalusite,

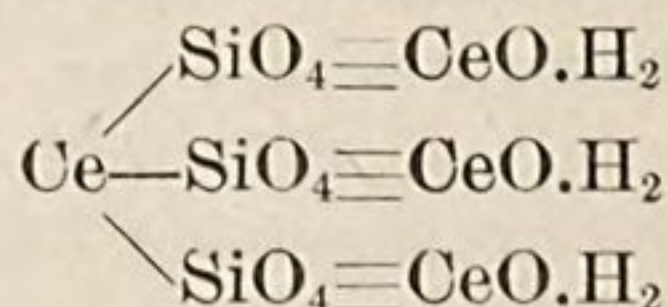


Neither formula is sustained by any good evidence. Other clays are possibly as follows:

Samoite	$\text{Al}_4(\text{SiO}_4)_3 \cdot 10\text{H}_2\text{O}$
Cimolite	$\text{Al}_4(\text{Si}_3\text{O}_8)_3 \cdot 6\text{H}_2\text{O}$
Collyrite	$(\text{AlO})_4\text{SiO}_4 \cdot 6\text{H}_2\text{O}$
Schrötterite	$(\text{AlO}_2\text{H}_2)_4\text{SiO}_4 \cdot 6\text{H}_2\text{O}$

None of these formulæ can be construed as anything more than a temporary suggestion, which may help research. The hydrous ferric silicates are, if anything, less satisfactory than the aluminum salts. Anthosiderite is representable by the formula $\text{Fe}_4(\text{Si}_3\text{O}_8)_3 \cdot 2\text{H}_2\text{O}$; and chloropal by the expression $\text{Fe}_2(\text{SiO}_4)_3\text{H}_6$. Hisingerite seems to range from a ferric kaolin to a ferric halloysite, and farther than this it is not worth while to go. The remaining iron clays which have received specific names are altogether doubtful. The chromium clays, wolchon-skoite, etc., are also of uncertain character.

To cerite, which is of doubtful composition, the provisional formula



may be assigned. Other earth metals—lanthanum, the two didymiums, etc.—replace a considerable part of the cerium. With cerium only the formula requires

SiO_2	20.22
Ce_2O_3	73.71
H_2O	6.07
	100.00

Cenosite, $\text{H}_4\text{Ca}_2\text{Y}_2\text{CSi}_4\text{O}_{17}$, and ardennite, $\text{H}_5\text{Mn}_4\text{Al}_4\text{VSi}_4\text{O}_{23}$, can each be written structurally in more than one way, with no determining evidence upon which to base a decision. They may be orthosilicates or

diorthosilicates; the vanadium in ardennite may be combined as VO_3 or as VO_4 , or it may form part of a complex vanadio-silicic acid, and between these alternatives there is no present means of deciding. To carpholite the formula $\text{H}_4\text{MnAl}_2\text{Si}_2\text{O}_{10}$ is commonly assigned, but the analyses vary from this composition too widely. Even with this formula carpholite may be either an orthosilicate or a basic metasilicate, and we can only say with regard to this species that further investigation is necessary.

Spodumene, acmite, jadeite, and the corresponding members of the amphibole group will be considered in connection with the metasilicates. It is quite possible that these minerals are really pseudo metasilicates, and that they should properly be discussed now. Their study is deferred on mineralogical grounds solely.

Three other salts of triad bases may be noted here, as having more analogy with the salts of aluminum than with any other silicates. They are pseudobrookite, an orthotitanate of iron, $\text{Fe}_4(\text{TiO}_4)_3$, and the bismuth silicates, eulytite and agricolite, $\text{Bi}_4(\text{SiO}_4)_3$. The two last-named species differ in form but are identical in empirical composition. They, therefore, suggest two types of chemical structure among the silicates of trivalent bases.

CHAPTER IV.

THE ORTHOSILICATES OF DYAD BASES.

Although the orthosilicates of the dyad metals are presumably simpler than those of aluminum, the problem of their constitution, studied in the light of mineralogical evidence, is peculiarly difficult. Starting points exist, in the salts of magnesium, iron, manganese, zinc, and glucinum, but the derivatives are fewer than in the case of aluminum, and the evidence upon which to base argument is proportionally limited.

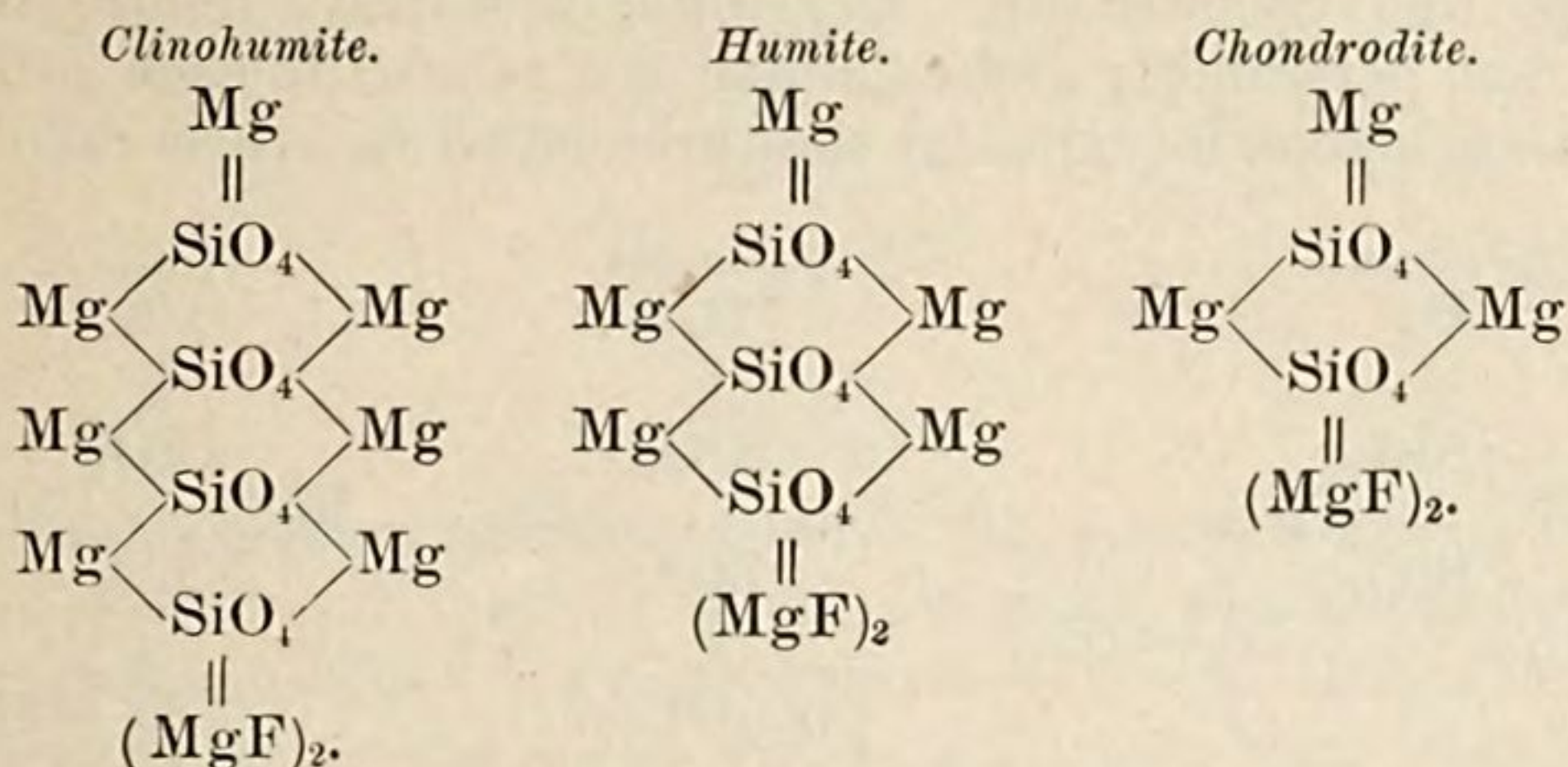
Expressed in the simplest terms, the normal orthosilicates of this group are represented by the general formula R_2SiO_4 . To this type the following minerals correspond:

Forsterite	Mg_2SiO_4
Fayalite	Fe_2SiO_4
Tephroite	Mn_2SiO_4
Willemite	Zn_2SiO_4
Phenakite	Gl_2SiO_4
Monticellite	$CaMgSiO_4$
Knebelite	$MnFeSiO_4$

Between these minerals there are many intermediate species or varieties, which may be either isomorphous mixtures or double salts representing polymers of the fundamental type. Thus, chrysolite or olivine may be a mixture of forsterite and fayalite, or, in the case of hyalosiderite, a salt of the formula $Mg_4Fe_2(SiO_4)_3$. So also, allied to knebelite, we have igelströmite, $Fe_4Mn_2(SiO_4)_3$; and in trimerite we find the salt $Gl_3Mn_2Ca(SiO_4)_3$.

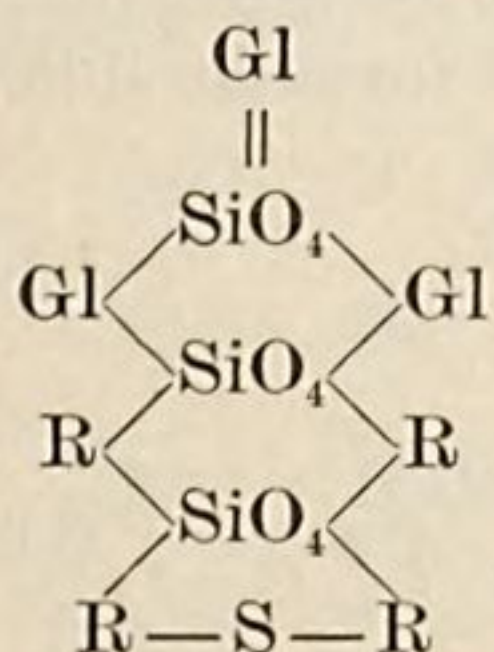
Upon studying closely the derivatives of these normal salts, the assumption of polymerization seems to be necessary. If the theory of substitution is valid, then the existence of polymers must be taken for granted; and upon this basis it becomes possible to develop a system of formulæ which satisfies all the conditions imposed by the evidence now at hand. For some of the species already mentioned the degree of polymerization is difficult to determine, and synthetic investigations seem to be needed. In other cases the problem is comparatively simple, and the indications as to the true formulæ are apparently clear. For instance, a good example is furnished by the chondrodite group, for

which we have the empirical formulæ established by Penfield and Howe.* Structurally written these become



or derivatives respectively of the salts $\text{Mg}_8(\text{SiO}_4)_4$, $\text{Mg}_6(\text{SiO}_4)_3$, and $\text{Mg}_4(\text{SiO}_4)_2$, with one atom of magnesium in each case replaced by the two univalent —Mg—F groups. The clinohumite occurs in association with forsterite, and the two species have nearly the same specific gravity. Hence forsterite may be $\text{Mg}_8(\text{SiO}_4)_4$, and this is the only datum available from which to infer its molecular magnitude. The synthetic transformation of forsterite into clinohumite, if it could be effected, would go far toward settling the question.

In the case of phenakite the triple formula $\text{Gl}_6(\text{SiO}_4)_3$ is rendered probable by the existence of trimerite, $\text{Gl}_3\text{Mn}_2\text{Ca}(\text{SiO}_4)_3$. It is also emphasized by the species helvite and danalite, which contain sulphur, probably combined in the dyad group —R—S—R— . Both of these species, in all of their known occurrences, agree with the general formula

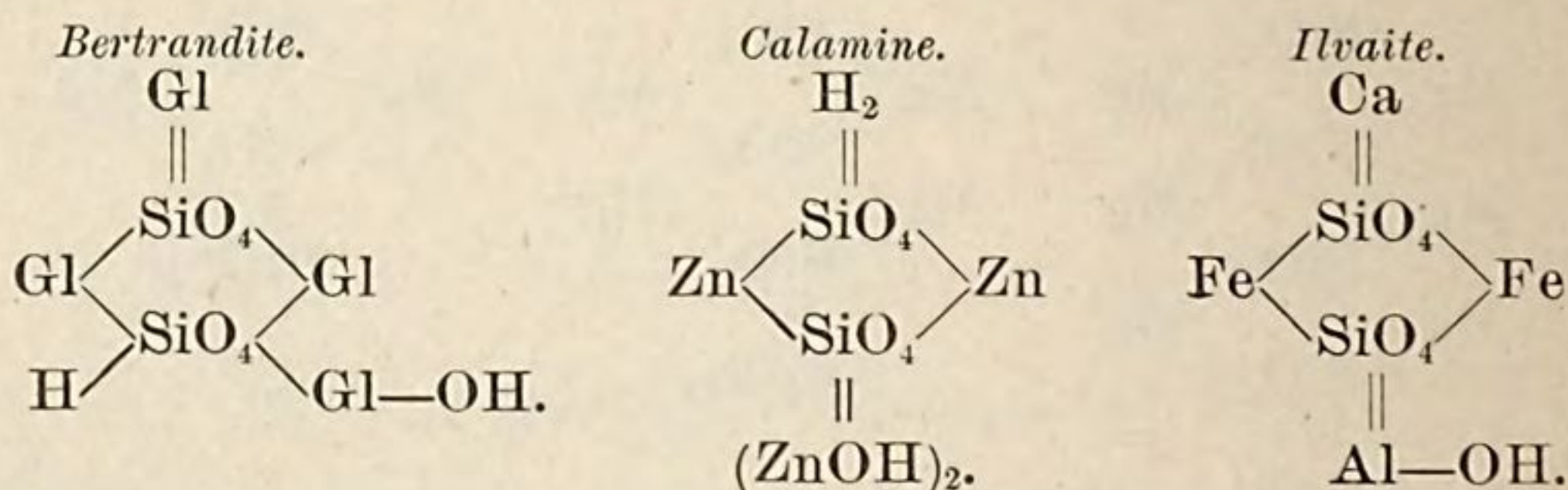


in which R may be either Fe'' , Mn, or Zn. The R is variable, but the other constituents are constant. In helvite, Mn and Fe occur, and in danalite zinc appears. In the Colorado danalite Zn predominates largely over Fe, and there is very little Mn. The Rockport danalite has Fe in excess of Zn, and rather more Mn. The Cornish danalite is very low in Zn, and the Fe largely exceeds the Mn. The ratio $\text{Gl}:\text{SiO}_4::3:3$, however, holds for all.

If phenakite is $\text{Gl}_6(\text{SiO}_4)_3$, then willemite, which is morphologically similar, is probably $\text{Zn}_6(\text{SiO}_4)_3$, with zinc partly replaced by manganese in the variety known as troostite.

* Am. Jour. Sci. (3), XLVII, p. 188, 1894.

The three orthorhombic species, bertrandite, calamine, and ilvaite, may be most conveniently represented as derivatives of the bipolymer $R_4(\text{SiO}_4)_2$, like chondrodite. Crystallographically, ilvaite resembles humite, but bertrandite and calamine are related to each other. The simplest analogous formulæ for the three minerals are as follows:

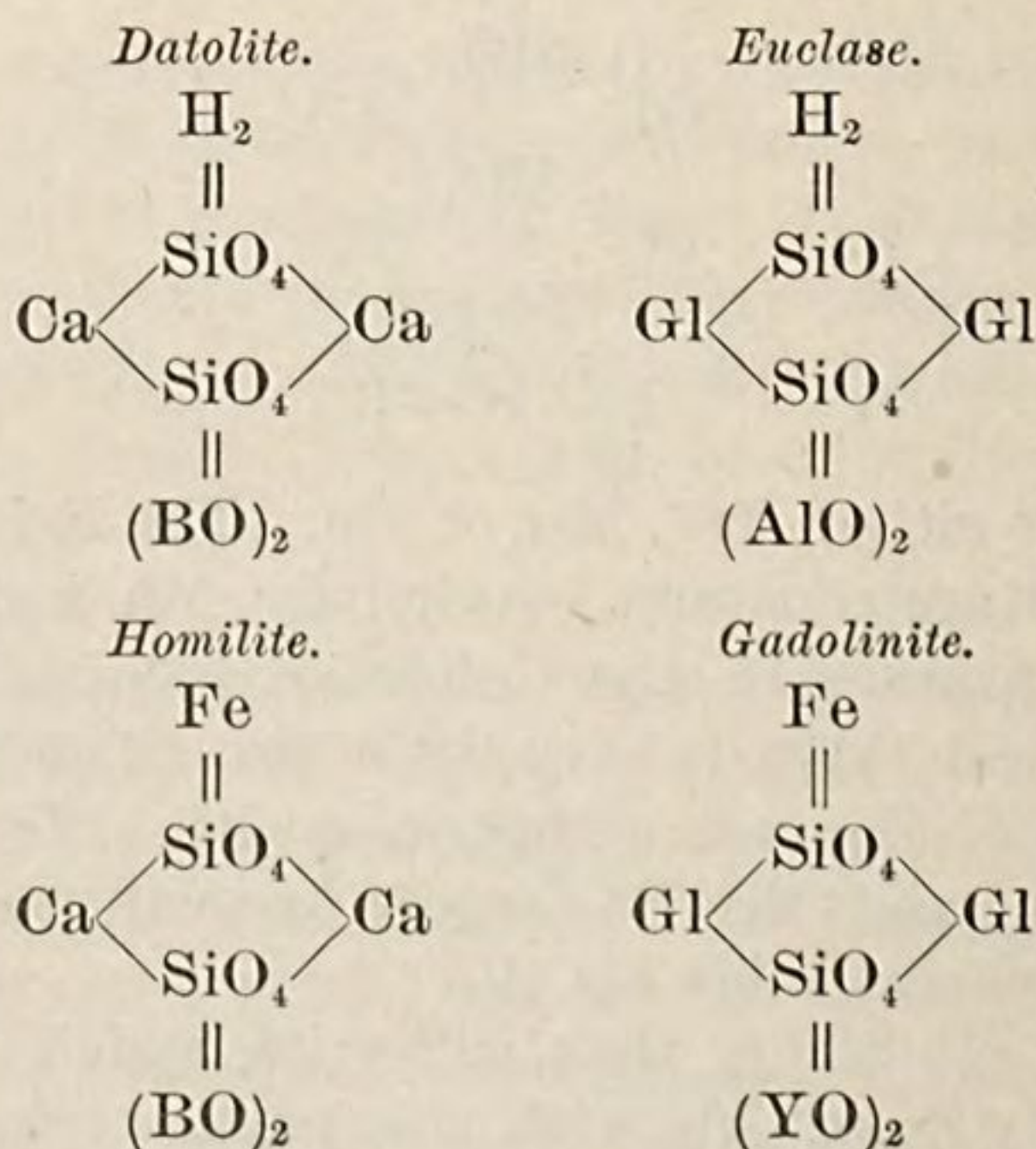


Calamine may also be written as a metasilicate, $(\text{ZnOH})_2\text{SiO}_3$, with half of the formula indicated above, but then the analogy with bertrandite disappears. The structure proposed is, therefore, preferable, at least until more evidence has been accumulated.

To the datolite group a similar constitution is ascribable. The species, reduced to their simplest empirical expressions, are these:

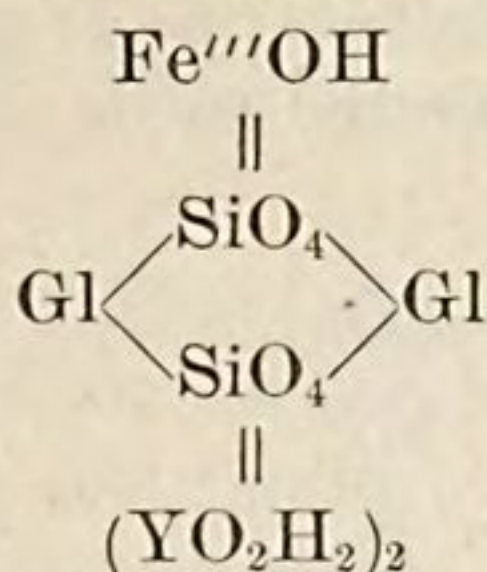
Datolite.....	HCaBSiO_5
Homilite	$\text{Ca}_2\text{FeB}_2\text{Si}_2\text{O}_{10}$
Euclase	HGlAlSiO_5
Gadolinite.....	$\text{Gl}_2\text{FeY}_2\text{Si}_2\text{O}_{10}$

By doubling the formulæ of datolite and euclase, all four of the minerals become similar in constitution. Hydrogen, here, is evidently basic, and boron must play the same part as aluminum and yttrium. Assuming these elements to be present in the univalent groups BO, AlO, and YO, the subjoined formulæ follow:



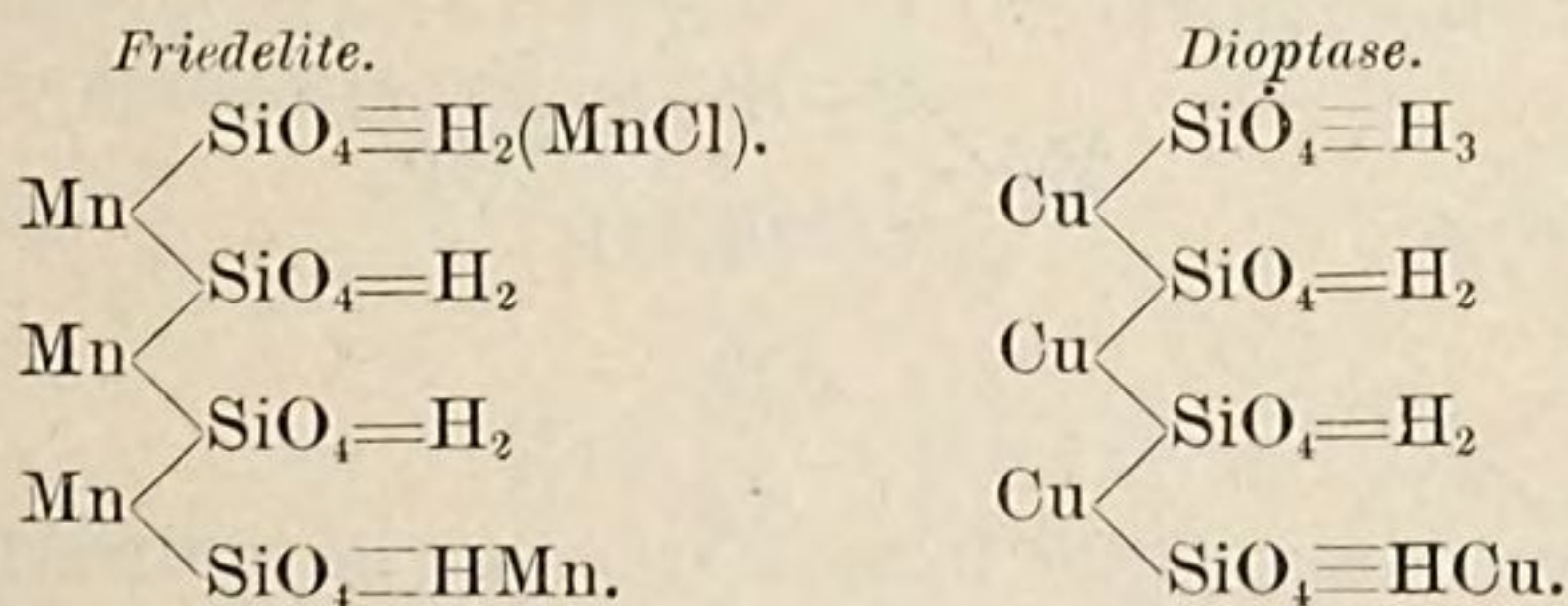
Gadolinite alters with great ease, passing by hydration into a brownish-red earthy substance. The analyses of this substance, which is

probably never pure and definite, are not altogether satisfactory; but they indicate in a general way a transformation into the compound

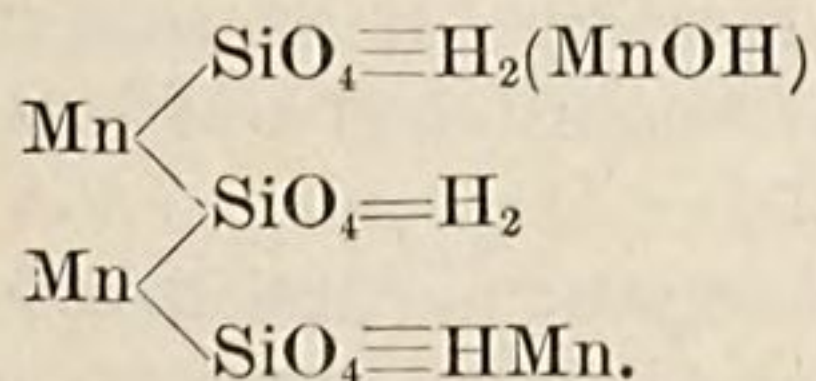


to which the alteration product very roughly approximates.

It will be observed that all of the foregoing structural formulæ in this group of compounds are rings or series of rings. From them, however, chain-like molecules are derivable, and these seem to exist in the cases of friedelite, pyrosmalite, and diopside. The last-named mineral, simply written, is CuH_2SiO_4 ; but it is morphologically related to the two other species, which have a much greater complexity of composition. The following expressions derived from the polymer $\text{R}_3(\text{SiO}_4)_4$ are probably the best to represent existing evidence:



Pyrosmalite is like friedelite, but with a large part of the manganese replaced by iron. Possibly karyophilite may be similar, having the formula

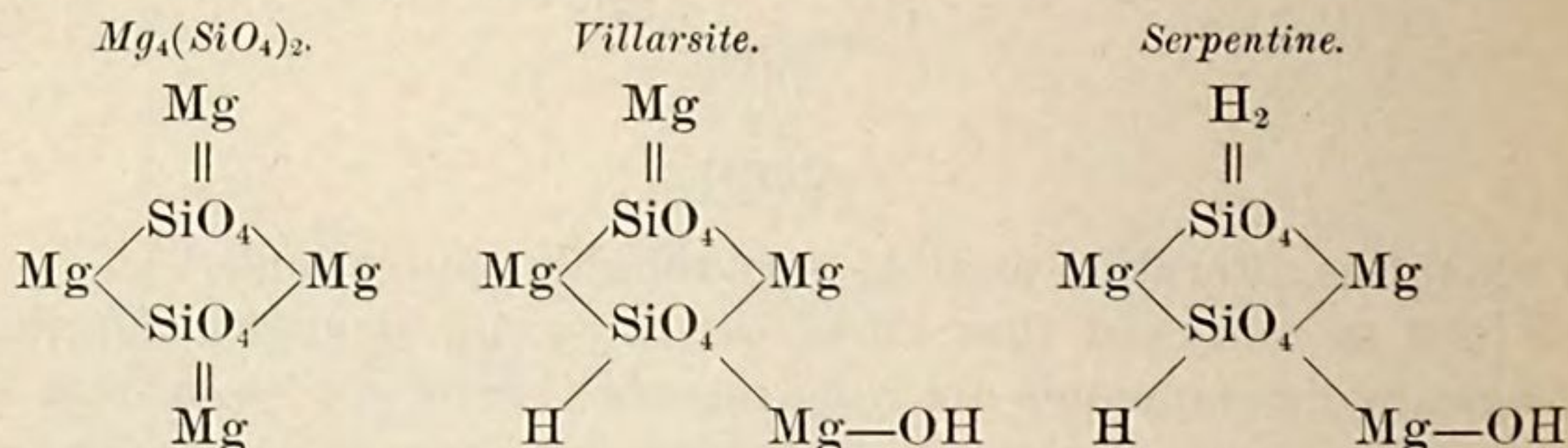


These formulæ are purely tentative and need additional support. By synthetic and genetic investigations they may be supported or overthrown. That they sustain one another, and fit in well with the formulæ of the preceding species, is all that can be said in their favor.

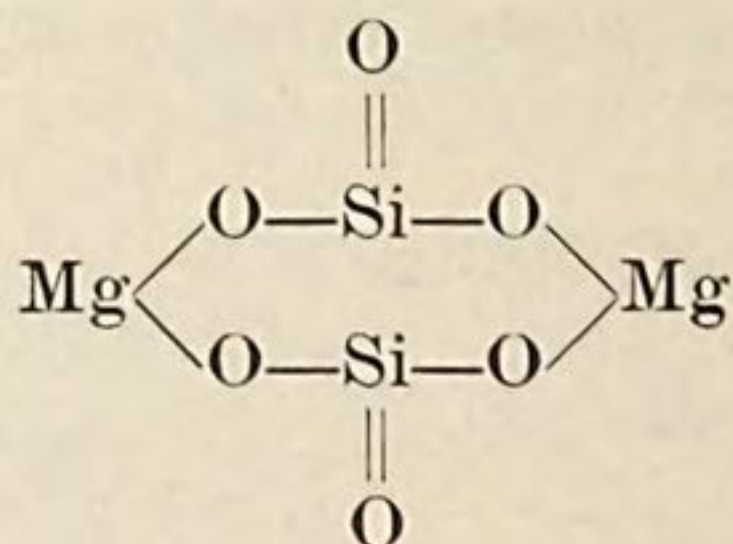
For serpentine, $\text{H}_4\text{Mg}_3\text{Si}_2\text{O}_9$, several formulæ are possible, and concerning them there has been much discussion. The species commonly originates in nature from the alteration of olivine on the one hand and from pyroxene or amphibole on the other, and it is therefore conceivable that it may include two or more isomeric compounds. In favor of this supposition there is no direct evidence, but still it should not be left entirely out of account.

By some authorities serpentine is regarded as an orthosilicate, and by others as a salt of the acid $\text{H}_6\text{Si}_2\text{O}_7$. On the latter supposition it

becomes $\text{Mg}=\text{Si}_2\text{O}_7\equiv\text{H}_2(\text{MgOH})_2$, which may be derived either from $2\text{Mg}_2\text{SiO}_4$ or 2MgSiO_3 , with loss of magnesium in one case and gain in the other. On the orthosilicate basis it is simply derivable from the polymer $\text{Mg}_4(\text{SiO}_4)_2$, and is related to the intermediate alteration product villarsite, as follows:



On this scheme the formula for serpentine corresponds with that of chondrodite; and the fact that the latter mineral alters readily into serpentine is strong evidence in its favor. If pyroxene is written structurally



the derivation of serpentine from it by action of infiltrating magnesian solutions becomes easy to understand, and the orthosilicate formula for serpentine is rendered still more probable. In short, that formula best indicates the genetic relationships of serpentine, and on these grounds is preferable to the alternative diorthosilicate expression. The latter is not disproved; it is simply rendered less advantageous as regards existing evidence, which is the evidence now to be interpreted.

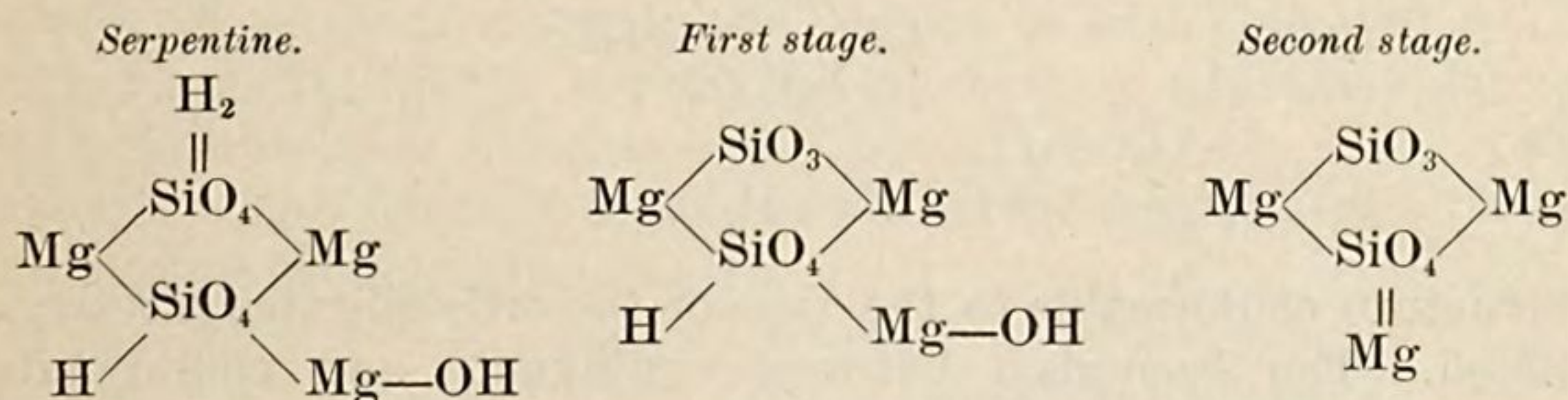
In some former investigations, carried on jointly with Dr. Schneider,* I sought to obtain experimental data in support of the orthosilicate formula here assigned to serpentine. By acting on serpentine with dry gaseous hydrochloric acid we found that a part of the magnesium could be removed as chloride, while olivine and the magnesian micas were not attacked. At first it seemed probable that the reaction would give a quantitative measure of the magnesium combined as MgOH ; but our later experiments and those of Lindner† have shown that the expectation was not well founded. I still believe, however, that the reaction discriminates between those magnesian silicates which contain MgOH and those which contain Mg and H combined otherwise, for only the members which must belong to the first class are acted

* Bull. U. S. Geol. Survey No. 78, p. 11; Bull. No. 90, p. 11, and Bull. No. 113, pp. 27 and 34.

† A. Lindner, Inaugural Dissertation, Breslau, 1893.

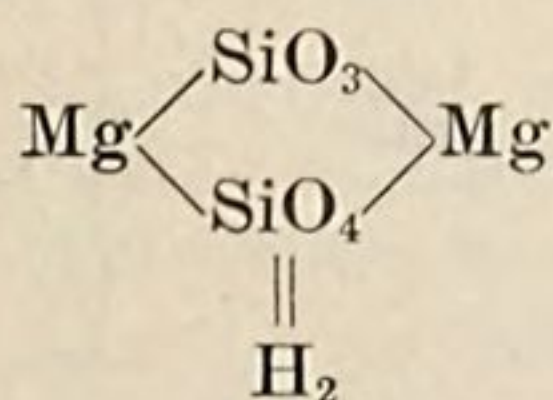
upon by the reagent. Brauns's objections* to this supposition, on the ground that the dry hydrochloric acid becomes moist, are not well taken, for the reaction was always applied at temperatures lower than those at which water is given off. His criticisms may apply to the later stages of the reaction, after it has once fairly begun, but not to its initiation. The magnesian micas which contain several per cent of water are all decomposable by aqueous hydrochloric acid, but are scarcely touched by the dry gas, while on the other hand serpentine and the chlorites are strongly attacked. After the gaseous acid has acted it becomes moist, but very slowly, and most of the moisture is carried past the mineral under investigation before it has had time to produce an appreciable effect. It is possible, however, that a slow stream of the acid may act differently from a rapid current, and that the discordant results of observation may be due to differences of this kind.

When serpentine is ignited, water is expelled, and a residue having the composition $\text{Mg}_3\text{Si}_2\text{O}_7$ is left behind. According to Rammelsberg† the water is given off in two portions—one-half upon weak ignition, the other after heating more strongly. On the orthosilicate theory these stages may be represented thus:



At the end of the second stage, if the ignition has not been too intense, the residue is still decomposable by hydrochloric acid, but by prolonged heating it is broken up quantitatively into soluble olivine and insoluble enstatite.

Allied to serpentine is the somewhat doubtful picrosmine, to which the formula $\text{Mg}_2\text{H}_2\text{Si}_2\text{O}_7$ is commonly assigned. Although this expression suggests a diorthosilicate, it may also be written

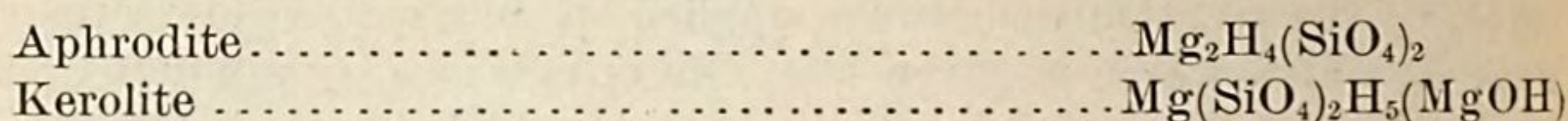


which represents picrosmine as a dehydrated serpentine altered subsequently by rehydration, with replacement of one magnesium atom by two of hydrogen. This mode of interpretation brings the mineral into line with serpentine, and all the known relations of the species are adequately expressed

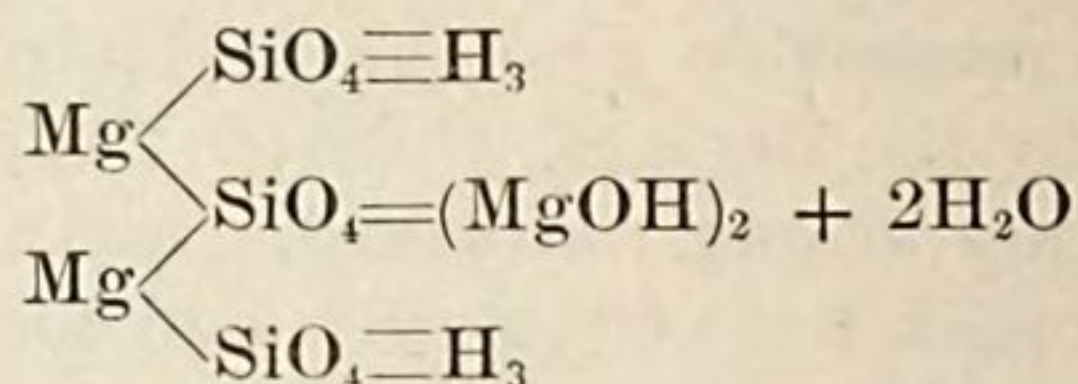
* Neues Jahrbuch, 1894. I, p. 205.

† Handbuch der Mineralchemie, 2 Aufl., p. 506.

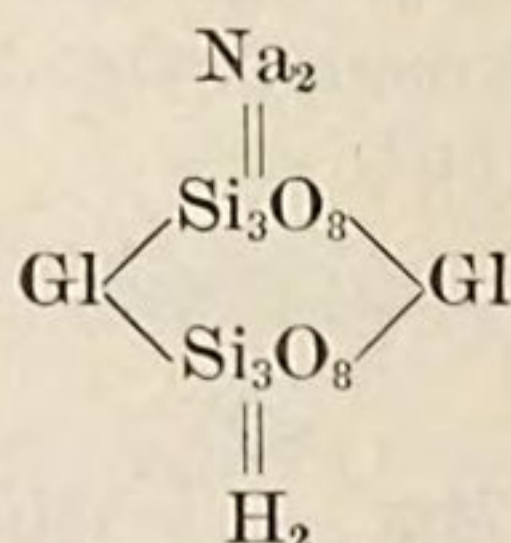
Several other hydrous silicates of magnesium seem to belong in this group, but their nature is altogether doubtful. Thus we have



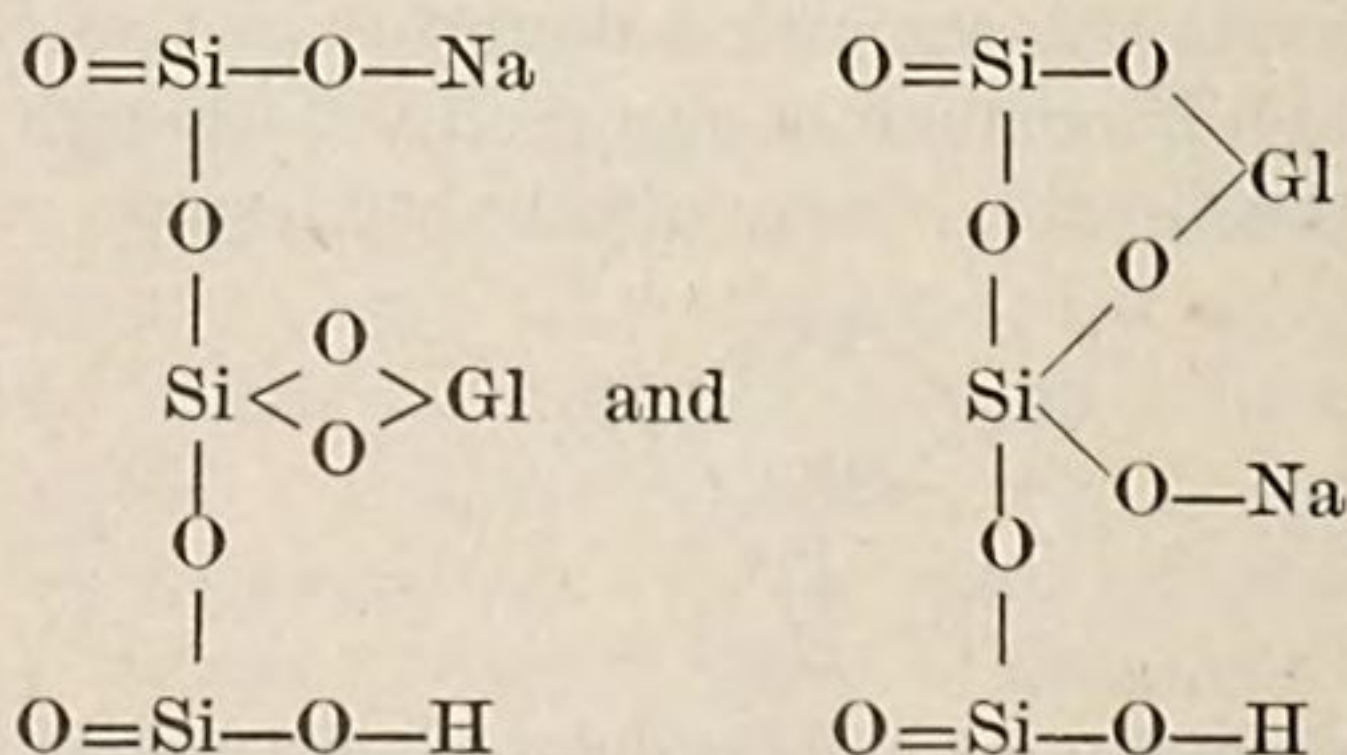
Deweylite is possibly



and genthite is similar, with part of the magnesium replaced by nickel. Sepiolite may be a trisilicate, with the formula $\text{H}_2=\text{Si}_3\text{O}_8=(\text{MgOH})_2$, in which case conarite is the corresponding nickel salt. These symbols are to be regarded as suggestions only. Two other trisilicates—eudidymite and epididymite—should also be noted at this point. The two species have the same empirical formula, $\text{HNaGlSi}_3\text{O}_8$, which, doubled, becomes



a structure conformable to the type of the orthosilicates already considered. The isomerism between eudidymite and epididymite is explainable by giving one species the constitution just written, while the other, in place of Na_2 and H_2 , would have the two groups NaH . It can also be ascribed to a different linking with the oxygen of the acid, and the empirical formula $\text{HNaGlSi}_3\text{O}_8$ can be put in two forms, thus:



a third isomer being also conceivable. The doubled formula, however, brings out analogies with bertrandite and other species and therefore, in default of evidence, is to be preferred.

CHAPTER V.

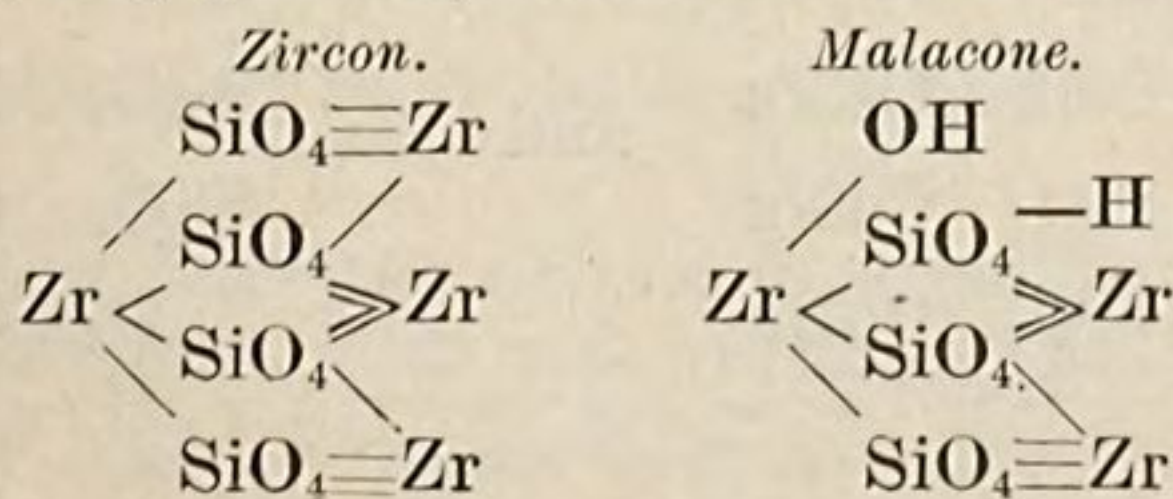
THE ORTHOSILICATES OF TETRAD BASES.

On account of their relatively small number and general scarcity, the silicates of the tetrad metals, titanium, zirconium, and thorium, are difficult to interpret in any satisfactory manner. Evidence exists, however, which seems to show that they are explainable by the same principles which apply to aluminum and the dyads, and that the theory of substitution from normal salts is a good working hypothesis to start from.

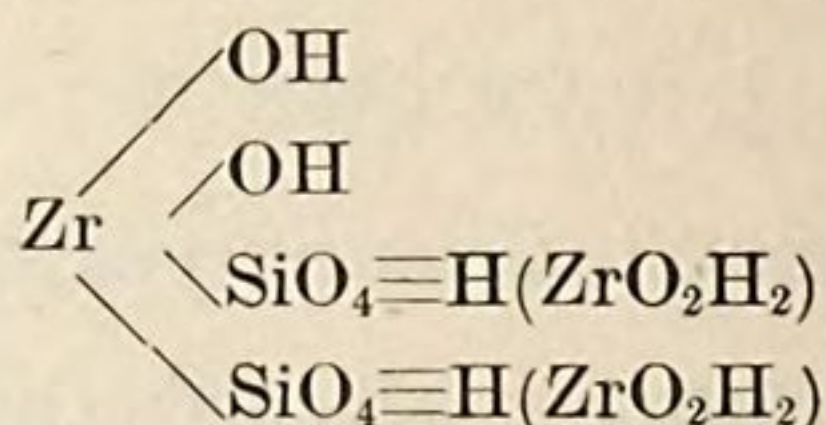
One definite normal salt is known in this series, the mineral zircon, ZrSiO_4 . As with the other inorganic silicates, the true molecular weight of this compound is unknown, and it can be inferred only from a study of its derivatives. If we assume it to be represented by the polymeric expression $\text{Zr}_4(\text{SiO}_4)_4$, it contains replaceable basic atoms, and a number of other zirconium silicates fall naturally into series derivable from this as the fundamental member. In this connection the mineral auerbachite is peculiarly suggestive, for its composition is best indicated by the formula $\text{Zr}_4(\text{Si}_3\text{O}_8)(\text{SiO}_4)_3$; which goes to show an important analogy between this group of silicates and those which have been previously considered. This formula, compared with Hermann's analysis of auerbachite, gives the following results:

	Hermann.	Calculated.
SiO_2	42.91	42.45
ZrO_2	55.18	57.55
FeO	.93	.....
H_2O	.95	.....
	99.97	100.00

Although zircon is a very stable and definite mineral, it alters by hydration into malacone, cyrtolite, and a variety of other indefinite substances which can not as yet be interpreted with any clearness. At the same time other bases, such as lime and the rare earths, are taken up, producing mixtures of great complexity. Malacone is probably the first hydration derivative, and its relations to zircon, regarding the latter as $\text{Zr}_4(\text{SiO}_4)_4$, may possibly be as follows:

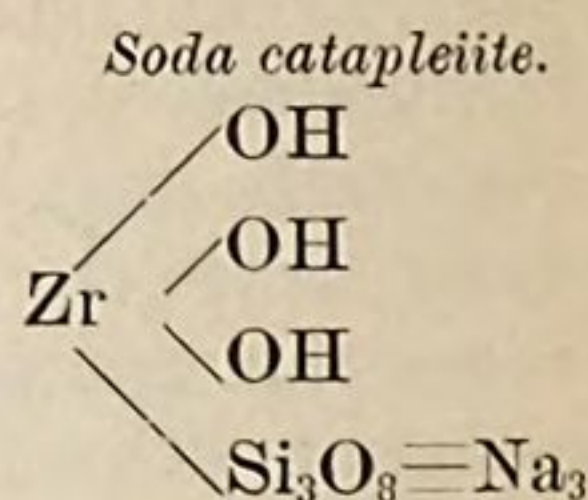
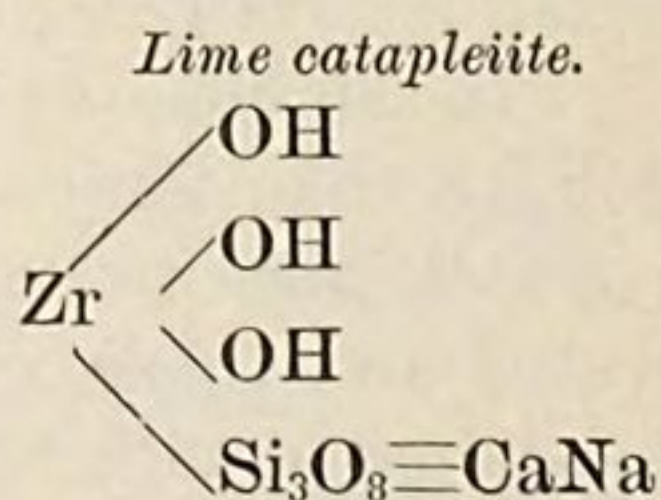
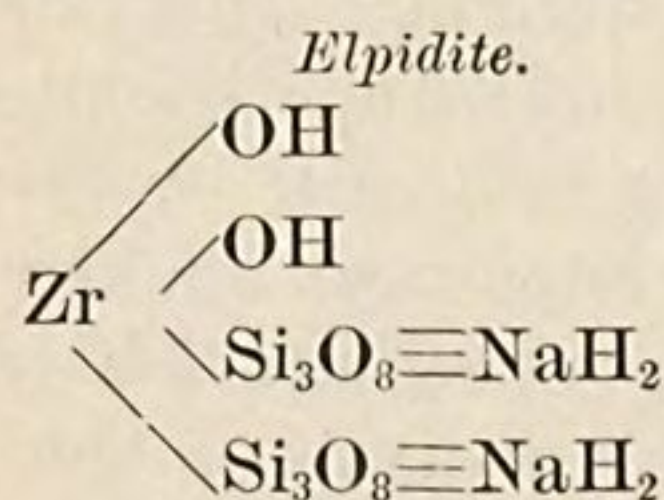


The original cyrtolite from Rockport is near malacone, but the cyrtolite from Colorado, analyzed by Hillebrand, approximates to



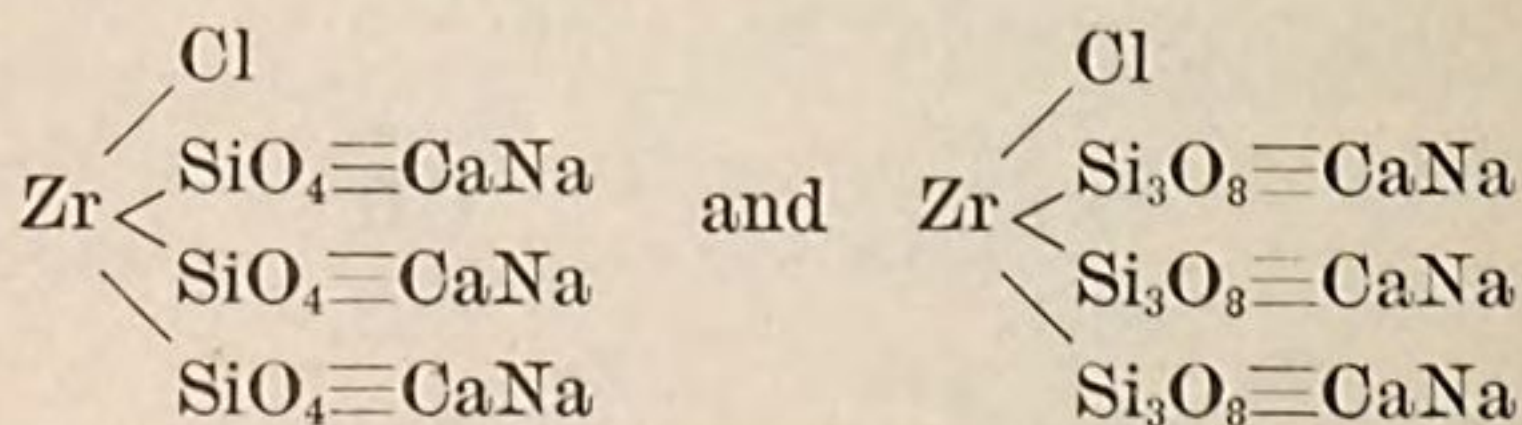
with part of the ZrO_2H_2 replaced by other bases. These formulæ, taken by themselves, are entitled to little consideration; but they become more significant when studied in connection with other compounds later. It will be noticed that one atom of zirconium is represented as linking four groups or radicles together; just as one aluminum atom has a similar triple function in the aluminous orthosilicates. This mode of linkage will be followed throughout this group of compounds.

In eudialyte, elpidite, and catapleiite we have a group of zirconium silicates which form a highly suggestive series. Taking the simpler members first, they may be represented thus:



Connecting these formulæ with zircon, we have the facts that Si_3O_8 occurs in auerbachite, and that at Låven, according to Brögger,* zircon is found both intergrown with catapleiite and pseudomorphous after it.

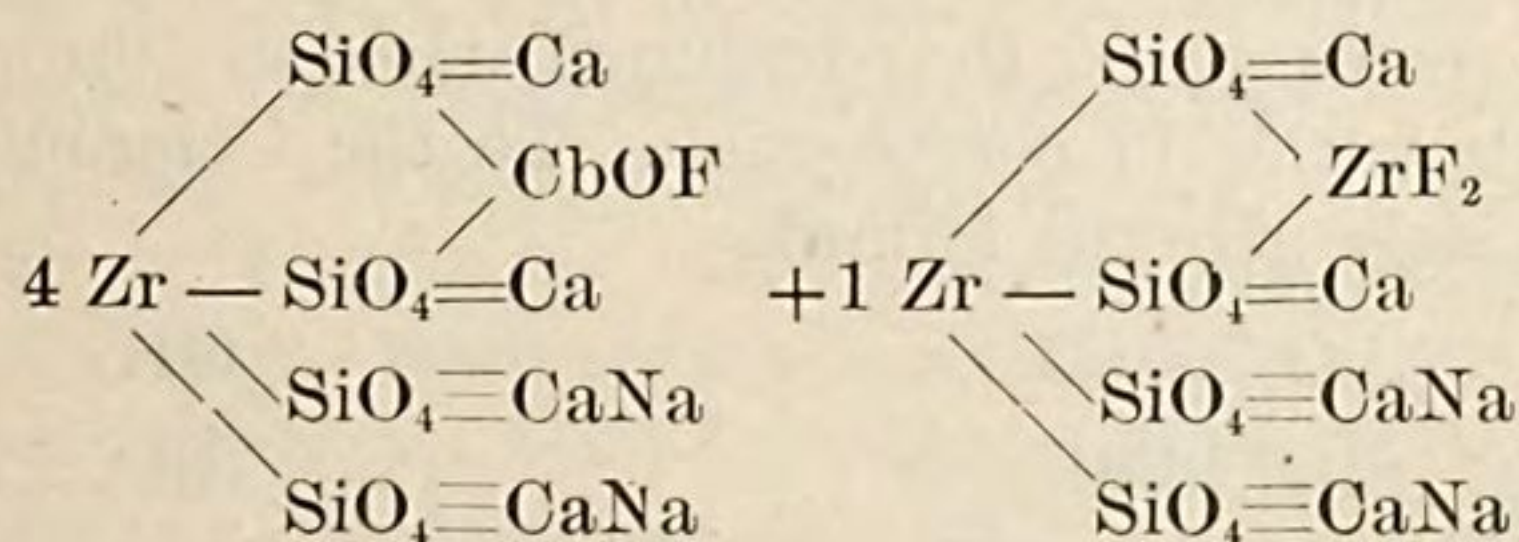
Eudialyte and eucolite are commonly regarded as metasilicates, with the compound ZrOCl_2 as an admixture. But the latter is not found in nature by itself, and both minerals, unlike most of the true metasilicates, gelatinize with acids. Furthermore, the analyses of eudialyte and eucolite show a considerable range of variation in the ratio $\text{Si} : \text{O}$, although approximating somewhat nearly to the assumed SiO_3 . If now we treat eudialyte and eucolite as mixtures of tri- and orthosilicates, like the feldspars, scapolites, and some micas, all difficulties vanish, the chlorine becomes equivalent to hydroxyl, and the minerals fall into line with catapleiite and elpidite as the first members of the series. All varieties of eudialyte and eucolite are then interpretable as mixtures of the two molecules



* Zeitsch. Kryst. Min., XVI, p. 105.

commingled in ratios nearly, but not exactly, 1 : 1. Hydroxyl replaces chlorine to some extent, while iron and manganese partly replace calcium; but the ratios shown by the formulæ are constant, and the structural analogies with the allied species are perfectly clear.

The remaining zirconium silicates, wöhlerite, rosenbuschite, lävenite, and hörtdahlite, are difficult to formulate conclusively. Brögger regards them as meta compounds, and as such they are classed with the pyroxenes; but the ratio Si:O is in each case very nearly 1:4. In wöhlerite, which contains columbium, the latter pentavalent element may be regarded as forming the dyad group =CbOF, and as equivalent to the similar group =ZrF₂. On this supposition wöhlerite can be written



with small amounts of the groups R'''F replacing ZrF₂. As thus written the calculated composition agrees fairly with Cleve's analysis, thus:

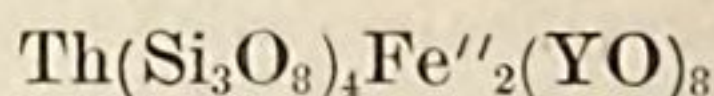
	Cleve.*	Calculated.	
SiO ₂	30.14	30.27	
TiO ₂	.42	}	18.46
ZrO ₂	16.12		
Cb ₂ O ₅	12.85		13.52
Fe ₂ O ₃	.48		.....
Ce ₂ O ₃	.66		.....
FeO	1.26	}	28.26
MnO	1.00		
MgO	.12		
CaO	26.97		
Na ₂ O	7.50		7.83
H ₂ O	.74		.....
F	2.98		2.87
	101.24		101.21
Less O	1.24		1.21
	100.00		100.00

* Zeit. Kryst. Min., XVI, p. 347.

The other "zircon pyroxenes" can be interpreted in a somewhat similar manner, but the results are less satisfactory. The analyses are complicated by the presence of small amounts of titanium, which may be either acid or basic, and more data are needed before formulation can become useful.

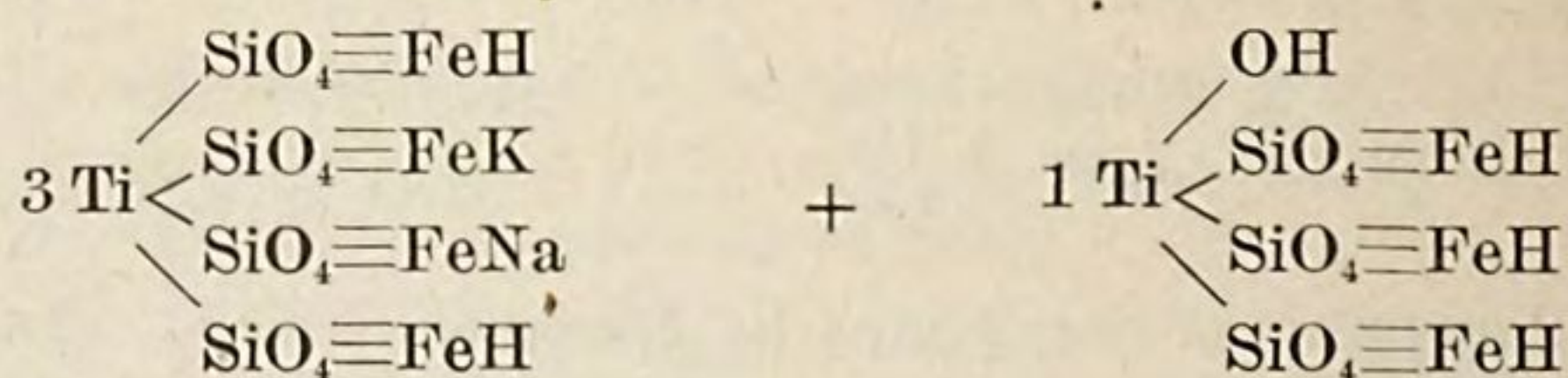
The typical silicate of thorium, thorite, or orangite is another unsatisfactory species on account of its wide variations in composition. It is commonly supposed that the mineral, as it exists in nature, has been

derived from an original ThSiO_4 by hydration; and that that ThSiO_4 was isomorphous with zircon. The nearest approach to the type is found in orangite, which may perhaps be regarded as a thorium cyrtolite, or thorium malacone. Yttrialite approximates to the composition



and in steenstrupine a thorium silicate exists which may be $\text{Th}(\text{SiO}_4)_4\text{Ca}_4\text{Na}_4$. Further discussion of these minerals at present would be fruitless. The data are wholly inadequate.

To the titanium silicates astrophyllite, johnstrupite, and rinkite similar formulæ to the foregoing are assignable. Indeed, this has already been done for astrophyllite by Brögger, who writes the formula $\text{Ti}(\text{SiO}_4)_4\text{R}''_4\text{R}'_4$. This seems to be the dominant molecule in astrophyllite, which, however, varies in composition. To the Colorado mineral we may more precisely give the formula

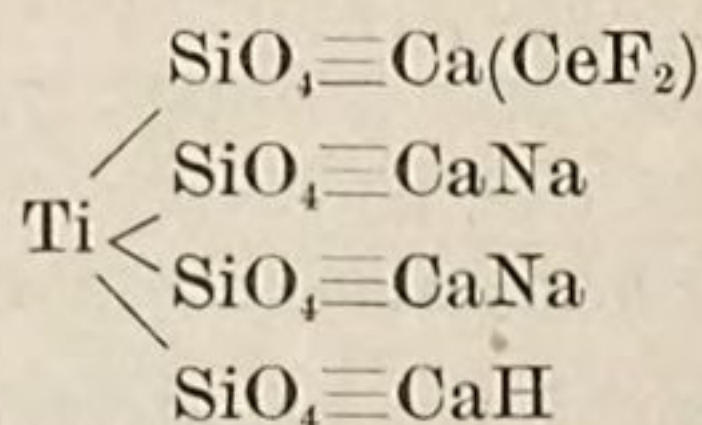


which requires

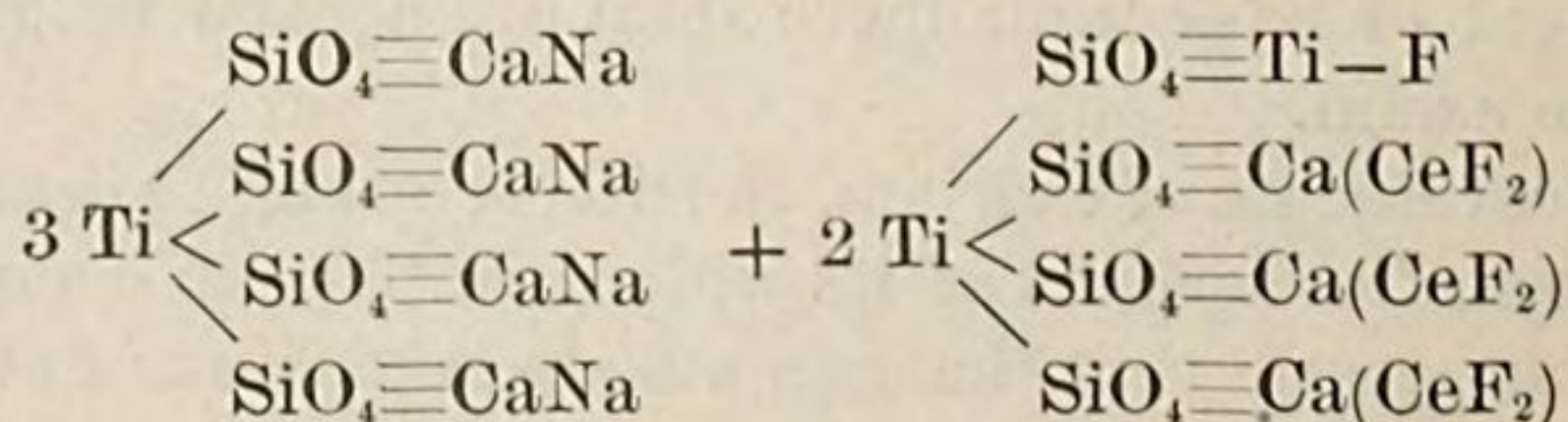
SiO_2	34.30
TiO_2	12.20
FeO	41.16
K_2O	5.36
Na_2O	3.55
H_2O	3.43
	100.00

Some iron is replaced by manganese, and ferric iron, perhaps as $=\text{Fe}-\text{OH}$, is also present. In the fluoriferous astrophyllites the fluorine should replace hydroxyl.

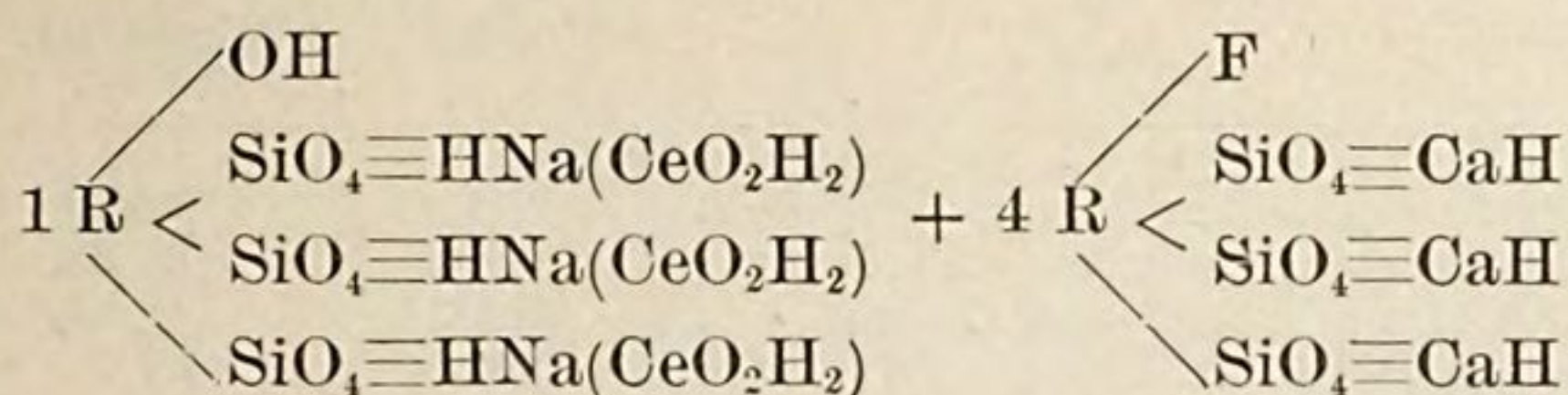
Johnstrupite and rinkite are both fluoriferous, and both contain earths of the cerium groups. In johnstrupite, a little ZrO_2 , ThO_2 , and CeO_2 replace some TiO_2 . For johnstrupite the expression



agrees well with the ratios given by analysis. In rinkite we have, with great probability, the mixture

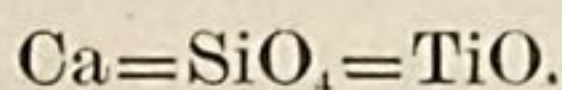


Even the complex mosandrite reduces to the same general type agreeing very closely with



in which $\text{R} = \text{Ce}^{\text{iv}} : \text{Zr} : \text{Ti} :: 1 : 2 : 2$. For each of these species the published analyses agree well with the composition calculated from these formulæ.

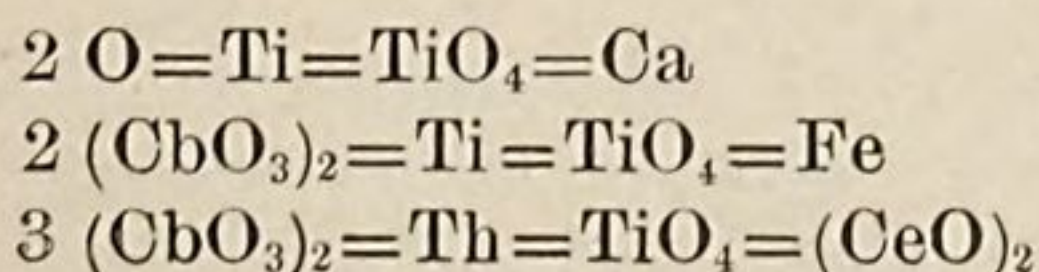
There is still another group of titaniferous silicates, represented by sphene, keilhauite, and tscheffkinite, which seems to be unconformable with the foregoing scheme of interpretation. Sphene, the typical member of the group, has the empirical formula CaTiSiO_5 , for which two distinct structures have been proposed. One regards the mineral as the calcium salt of an acid, H_2TiSiO_5 , analogous to $\text{H}_2\text{Si}_2\text{O}_5$, while the other treats it as a basic orthosilicate,



A careful study of the recorded analyses of sphene leads me to prefer the latter expression, for the actual ratios vary in a way which indicates a replacement, sometimes of Ca and sometimes of TiO by other bases. On the meta formula, only the calcium should be replaceable. This variability of ratio is well shown by some of the varieties of sphene, such as grothite, alshedite, and eucolite-titanite, but the data are not absolutely conclusive. If, however, sphene is a basic orthosilicate, it should be placed in the preceding chapter with datolite and the other calcium salts. On the other hand, the acid character of the titanium is suggested by the remarkable hydration derivative of sphene, xanthitane, of which the composition is approximately represented by the formula $\text{Al} \equiv \text{Ti}_2\text{O}_7 \equiv \text{H}_3$.

For tscheffkinite, as shown by Eakins' analyses, the composition is approximately $(\text{FeCa})_3\text{Ce}_6\text{Ti}_4\text{Si}_6\text{O}_{32}$, but the constitution of the mineral is very doubtful. Keilhauite appears to be like sphene, with Ca or TiO replaced by $\text{R}'''\text{OH}$ or $\text{R}'''\text{O}_2\text{H}_2$, but the analyses are widely discordant. The orthorhombic guarinite is generally assumed to be isomeric with sphene, although there is but one incomplete analysis from which to calculate.

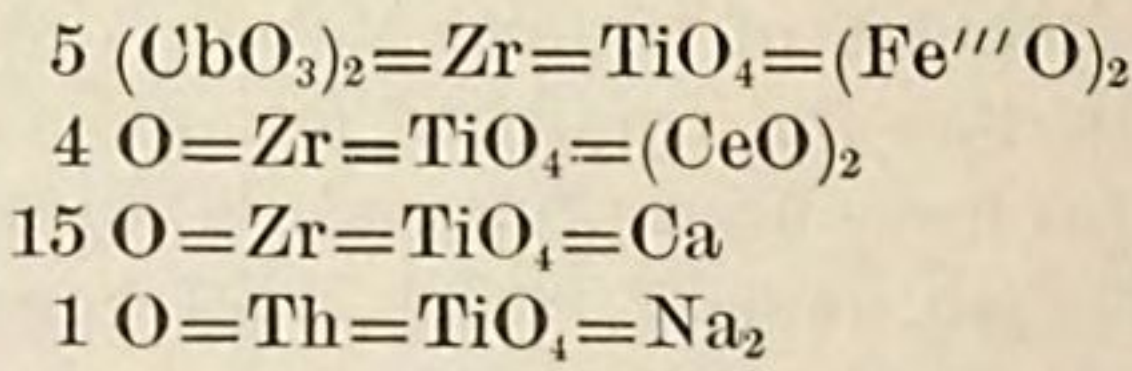
Some light may possibly be shed upon the sphene groups of mineral by a study of the columbo-titanates æschynite and polymignite. The composition of æschynite is very well represented by a mixture of molecules



which compares with Rammelsberg's analysis as follows:

	Found.	Calculated.
TiO ₂	21. 20	20. 70
ThO ₂	17. 55	18. 63
Cb ₂ O ₅	32. 51	31. 52
(Ce, La, Di) ₂ O ₃	19. 41	} 23. 14
(Y, Er) ₂ O ₃	3. 10	
FeO	3. 34	3. 38
Ca	2. 50	2. 63
	99. 61	100. 00

For polymignite a similar expression gives equally good results. It is



The similarity in type of these expressions to the orthosilicate formula for sphene is obvious. It is also obvious that the entire group is greatly in need of further study.

CHAPTER VI.

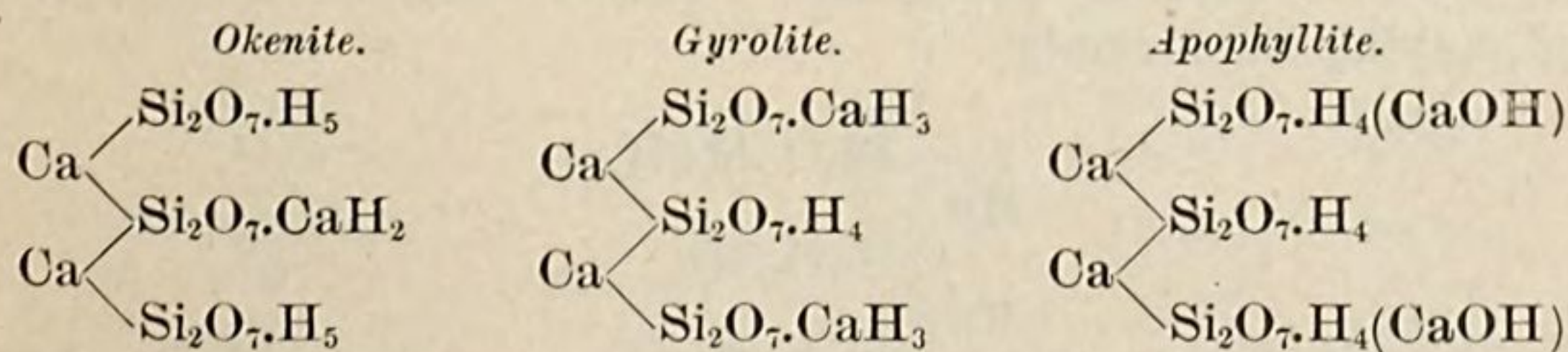
THE DIORTHOSILICATES.

Although the existence of the sexbasic acid $H_6Si_2O_7$ has been well established by the preparation of its ethers, its metallic salts are little known and uncertain. I have already shown, in the case of serpentine, that a mineral may be apparently a diorthosilicate, and yet equally well explainable otherwise; and what is true in that instance may be true in others. For the following species the diorthosilicate formulæ seem to be the best and simplest, even though they are not wholly free from objection. They fit existing evidence, but are not absolutely conclusive.

The typical member of this group of minerals is the hexagonal lead silicate, barysilite, $Pb_3Si_2O_7$. The artificial compound from the slags of Bonneterre, Mo., described by Dana and Penfield, is near this, and may have the composition $Pb_2CaSi_2O_7$. The tetragonal ganomalite is another similar compound, approximating to $3Pb_3Si_2O_7 + 2Ca_3Si_2O_7$, although the latest analysis agrees rather better with $Pb_3Si_2O_7 + Ca_2SiO_4$. Two other orthorhombic species, kentrolite and melanotekite, may be regarded as basic salts derived from barysilite, thus:

Barysilite	$Pb_2Si_2O_7Pb$
Melanotekite	$Pb_2Si_2O_7(Fe'''O)_2$
Kentrolite	$Pb_2Si_2O_7(Mn'''O)_2$

The group of zeolitic calcium silicates, okenite, gyrolite, and apophyllite, are unquestionably related to one another, and are best represented as salts of $H_6Si_2O_7$. In nature, gyrolite may be derived from apophyllite, and apophyllite also from gyrolite, while Doelter has generated apophyllite from okenite by artificial means.* First, by heating okenite with potassium silicate and water to 200° , crystals of apophyllite were obtained. Secondly, by heating okenite with aluminum chloride, sodium carbonate, and carbonated water together at 220° , apophyllite, analcite, and chabazite were produced. The most satisfactory general formulæ for the three species are these:

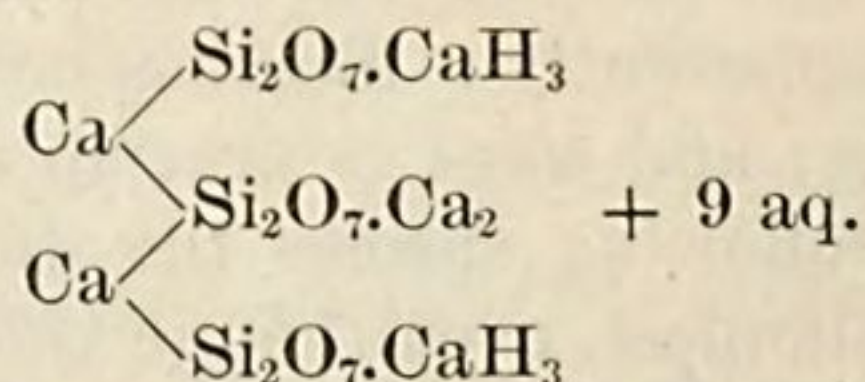


* Neues Jahrb., 1890, I, p. 118.

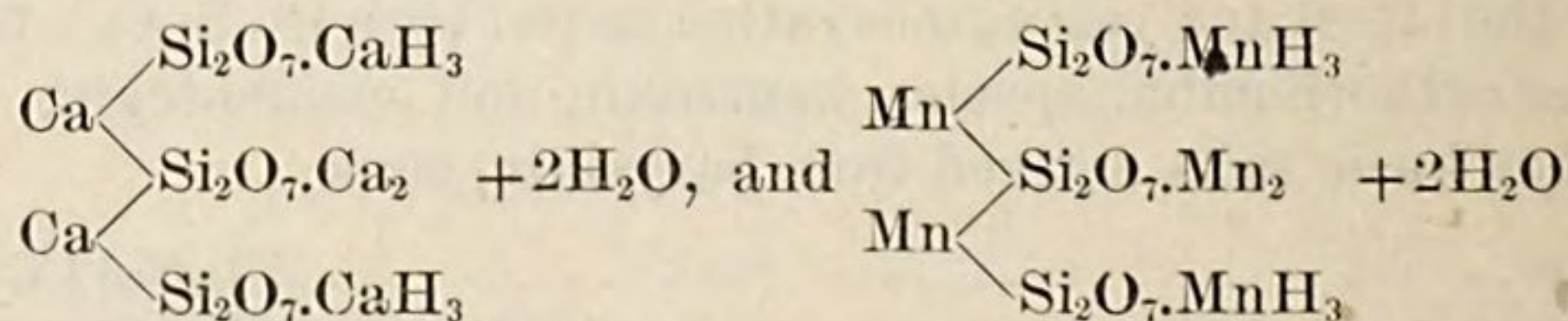
In apophyllite fluorine may partly replace hydroxyl, and K may replace the univalent CaOH. With $K : CaOH :: 1 : 1$ the composition of apophyllite becomes

SiO ₂	52.03
CaO	24.27
K ₂ O	6.79
H ₂ O	16.91
	100.00

The uncertain mineral plombierite may be a fourth member of this group, with the formula



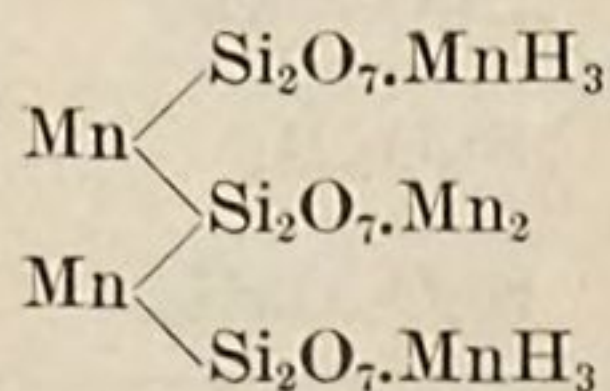
To the calcium-manganese silicate, inesite, various formulæ are assignable. By Flink it is regarded as $2(\text{CaMn})\text{SiO}_3 \cdot \text{H}_2\text{O}$. But part of the water is stable at temperatures above 300° ; and this fact is expressed by Schneider's formula $(\text{CaMn})\text{Si}_3\text{O}_8(\text{MnOH})_2 \cdot \text{H}_2\text{O}$. Both formulæ agree with the analyses approximately, but the latest analysis, that of Lundell,* is better represented by the following mixture:



which requires:

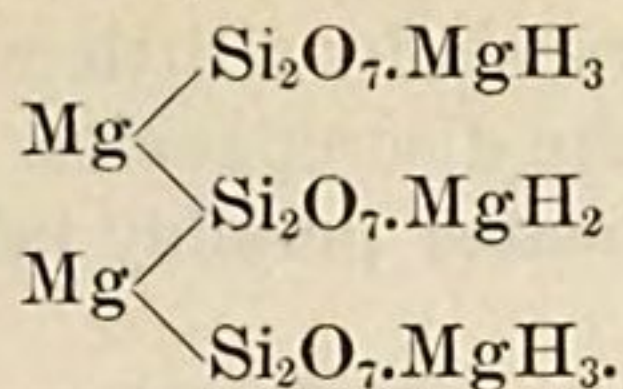
	Found, Lundell.	Calculated.
SiO ₂	42.92	42.18
PbO	.73	}
MnO	36.31	
MgO	.37	
CaO	8.68	
H ₂ O	10.48	
	99.49	100.00

With inesite another manganese silicate, bementite, is perhaps related, having the formula



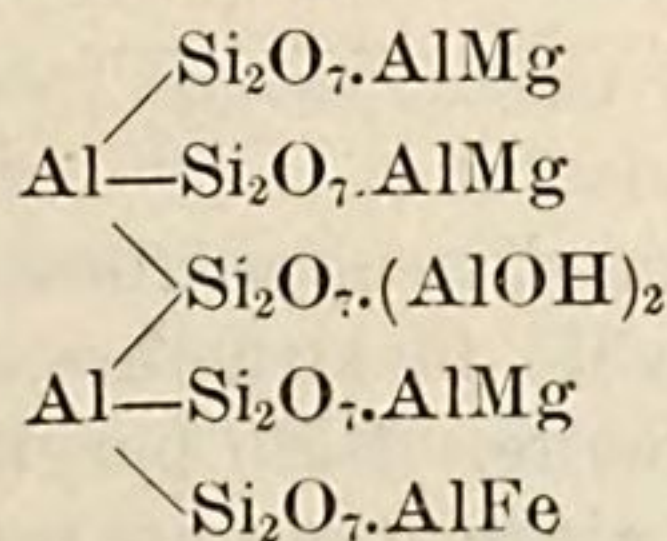
* See Hamberg, Geol. Fören. Förhandl., XVI, p. 325.

and the magnesian spadaite may be similar, with the composition



Another magnesian silicate, saponite, is perhaps normally $\text{H}_4(\text{MgOH})_2\text{Si}_2\text{O}_7$, although the analyses all show admixtures of some aluminous compound.

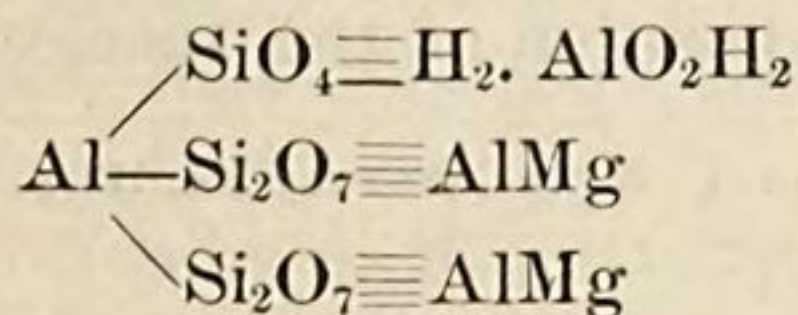
Among the silicates of aluminum, salts of diorthosilicic acid are very rare. The only one which seems to be at all well defined is iolite, which agrees best with the formula



which requires

SiO_2	49.26
Al_2O_3	33.50
MgO	9.85
FeO	5.91
H_2O	1.48
	100.00

in close concordance with the best recorded analyses. By alteration, iolite passes into mica, going through an intermediate stage, however, known as chlorophyllite. This substance may be regarded as formed by hydration, in which the linking group of Si_2O_7 in iolite is split into two orthosilicic radicles, yielding two molecules of the type

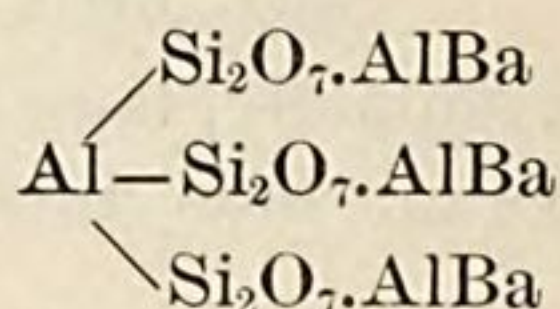


from which the final transition into a mica is easy. If we take Ram-melsberg's analysis of chlorophyllite, recalculate the ferric oxide into alumina and lime into magnesia, reducing afterwards to 100 per cent, we get the following comparison between observed fact and the composition of chlorophyllite computed from the foregoing formula:

	Found.	Reduced.	Calculated.
SiO_2	46.31	47.99	48.39
Al_2O_3	25.17	33.34	32.90
Fe_2O_3	10.99		
MgO	10.91	11.74	12.90
CaO	.58		
H_2O	6.70	6.93	5.81
	100.66	100.00	100.00

The agreement is as close as could be reasonably expected. The replacement of a little magnesia by a little water in the original alteration product accounts for the discrepancies.

Two other aluminous silicates possibly belong in this group. One, barylite, is near

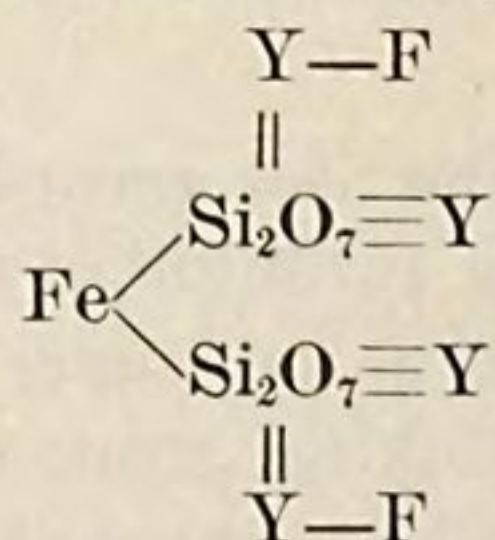


which requires

SiO ₂	35.19
Al ₂ O ₃	19.94
BaO	44.87
	100.00

The other silicate, spenoclaste, is approximately $\text{Al}_2(\text{Si}_2\text{O}_7)_3\text{Ca}_6$; which may be analogous to barylite in structure, or written as a calcium salt similar in type to okenite. Both barylite and spenoclaste, however, are uncertain, and their relations are not definitely known. The species glauconite, pholidolite, and celadonite, all of doubtful composition, seem also to have diorthosilicate ratios.

To the rare mineral rowlandite, in accordance with Hillebrand's analysis,* a diorthosilicate formula belongs, viz:



which expresses the composition of the species very closely.

* Bull. U. S. Geol. Survey No. 113, p. 45.

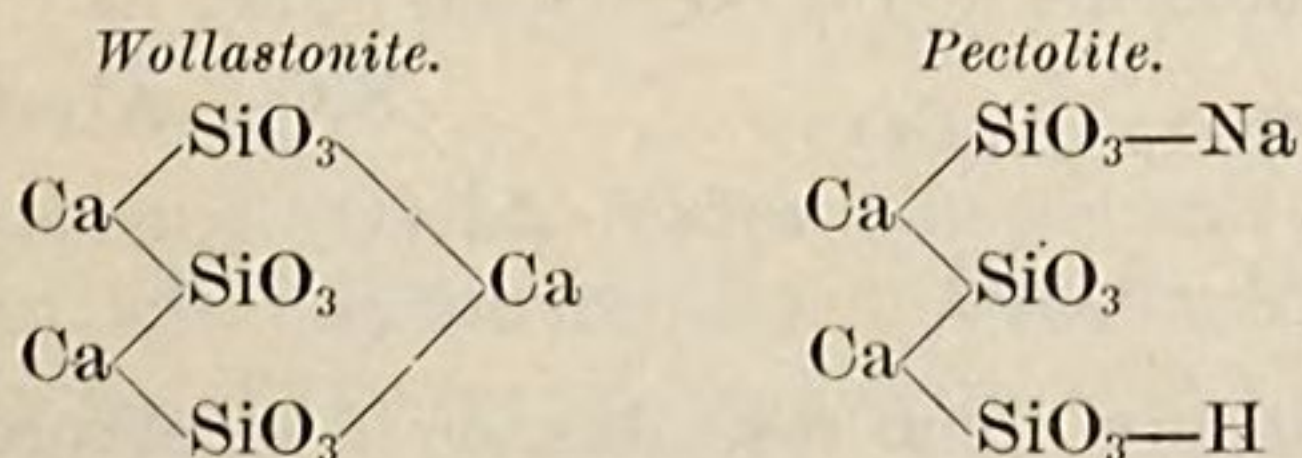
CHAPTER VII.

THE META AND DIMETASILICATES.

Although the metasilicates appear at first sight to be extremely simple, they are actually quite difficult to interpret. It is easy enough to deduce their empirical formulæ, and to write them afterwards in structural terms; but this is not sufficient. The structural formulæ must express all known relations in the case of each species, and in attempting to satisfy the established conditions the difficulties begin to appear. In the first place, metasilicic acid itself is defectively known, and no ether of the form R_2SiO_3 has yet been certainly obtained. Troost and Hautfeuille's ether $(C_2H_5)_8Si_4O_{12}$ suggests the possibility that metasilicic acid, like metaphosphoric acid, may polymerize, but an attempt to draw general conclusions on so important a supposition from one datum only would be most unwise. The possibility of polymeric acids, however, must be recognized.

Again, as we have repeatedly seen, a mineral may be apparently a metasilicate and yet really a mixture of ortho- and trisilicates. Even a basic trisilicate can have seemingly metasilicate ratios. All of these considerations complicate the identification and study of the true metasilicates to such an extent that only provisional conclusions can be drawn from the data now on hand.

A crystallized silicate of sodium, $Na_2SiO_3 \cdot 8H_2O$, is well known. A solution of this salt added to a solution of calcium chloride precipitates a compound which, dried over sulphuric acid, has, according to my own observations, the composition $Ca_2Si_2O_6 \cdot 5H_2O$. This, minus the water, is analogous to the mineral wollastonite, from which another mineral, pectolite, is derived. If wollastonite, instead of the formula $Ca_2Si_2O_6$, be given the formula $Ca_3Si_3O_9$, it may be compared structurally with pectolite, as follows:



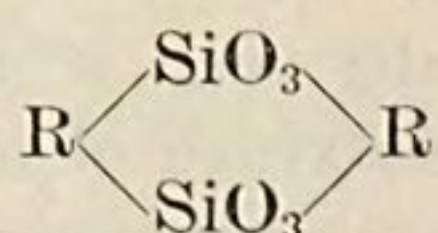
It must be remembered that the molecular weights of the inorganic silicates are not known, but only assumed; and the problem suggested

by the foregoing expressions is to find a set of structural formulæ which shall represent all of the available evidence. Now, wollastonite is commonly classed with the pyroxenes, on crystallographic grounds; and so too is pectolite. But both species are very easily decomposed by even dilute and weak acids, while the normal pyroxenes are quite refractory; and furthermore, wollastonite has a lower density than any pyroxene which approaches it in composition. Chemically, then, these species are dissimilar, and it is very doubtful whether they can properly be grouped together.

Empirically, however, the nonaluminous pyroxenes resemble wollastonite in their ratios. Thus we have, according to the commonly accepted formulæ developed by Tschermak, Doelter, and others:

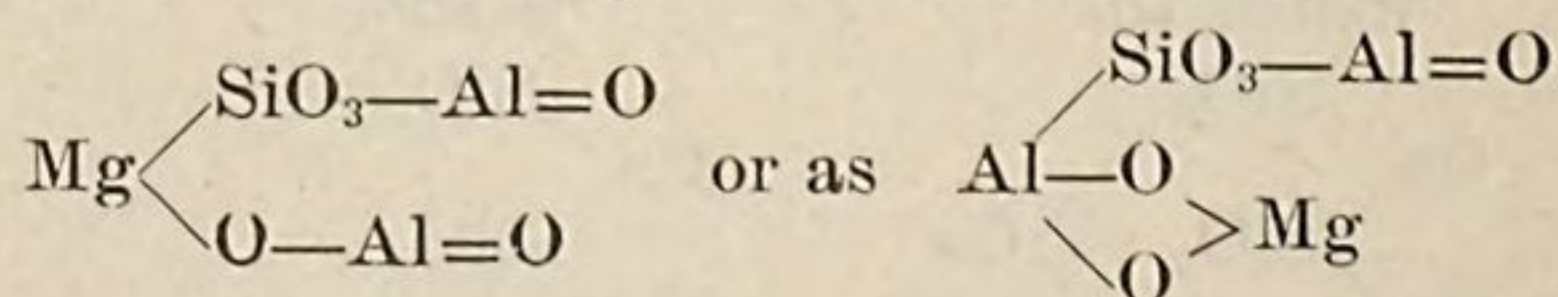
Enstatite, orthorhombic	$\text{Mg}_2\text{Si}_2\text{O}_6$
Diopside, monoclinic	$\text{CaMgSi}_2\text{O}_6$
Hedenbergite, monoclinic	$\text{CaFeSi}_2\text{O}_6$
Rhodonite, triclinic	$\text{Mn}_2\text{Si}_2\text{O}_6$

There is also a great variety of other intermediate species or isomorphous mixtures in the pyroxene series, such as bronzite, hypersthene, scheffterite, sahlite, jeffersonite, and fowlerite, in which we find, variously replacing one another, salts of magnesium, calcium, iron, manganese, and zinc. All of these minerals, however, conform to the general formula RSiO_3 , or $\text{R}_2\text{Si}_2\text{O}_6$, which adequately expresses their constitution so far as they alone are concerned. This, structurally, can be written



which would be satisfactory if the pyroxene series ended here and if the amphiboles were unknown.

Going a step farther we find in augite a pyroxene containing aluminum, and having an oxygen ratio greater than $\text{Si}:\text{O}_3$. In place of aluminum, ferric iron also occurs, and alkalies are sometimes present. Leaving these variations out of account, for consideration later, we have in augite, as interpreted by Tschermak, together with the normal compound $\text{R}_2\text{Si}_2\text{O}_6$, the basic salt RAlAlSiO_6 ; which, as shown by Groth, is empirically analogous to kornorupine. It is also similar in composition to the silicate which is characteristic of the clintonite micas; but the two are probably not identical. A metasilicate isomer of the clintonite molecule might be written either as



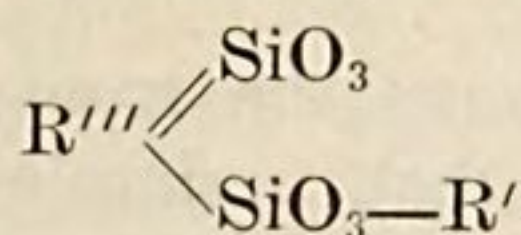
having in the first form some resemblance in structure to the metasilicate formula for the nonaluminous pyroxenes. The compound, however, unless represented by kornorupine, is not known by itself, but is assumed as existent in mixtures; its reality, therefore, is still question-

able. Its simplest representation would be as a basic orthosilicate, $\text{Mg}(\text{SiO}_4)(\text{AlO})_2$, and it will be seen later that a polymer of this form is far more satisfactory than any metasilicate expression.

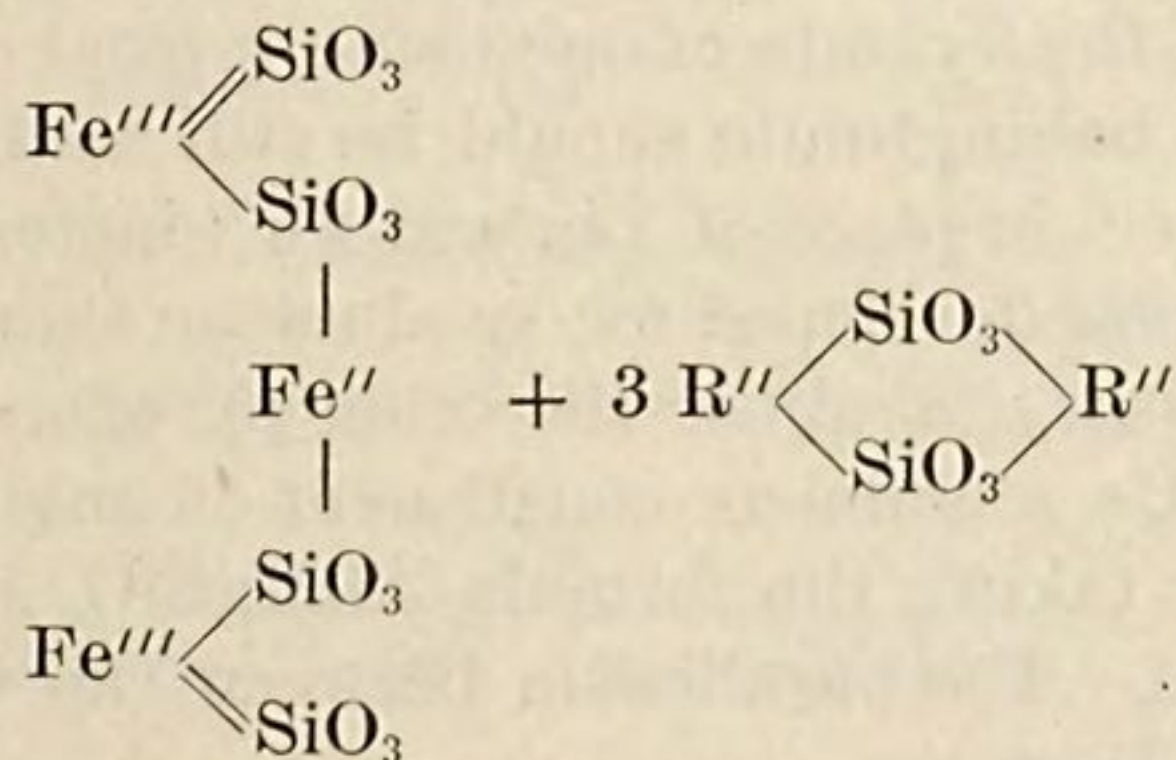
Still another series of silicates containing triad bases and also alkalis are classed with the pyroxenes, as follows:

Spodumene	$\text{AlLiSi}_2\text{O}_6$
Jadeite	$\text{AlNaSi}_2\text{O}_6$
Acmite	$\text{Fe}'''\text{NaSi}_2\text{O}_6$

and their empirical formulæ are fairly satisfactory. Structurally, these expressions become, as metasilicates,



and babingtonite, which contains no alkalies, is similar, thus:



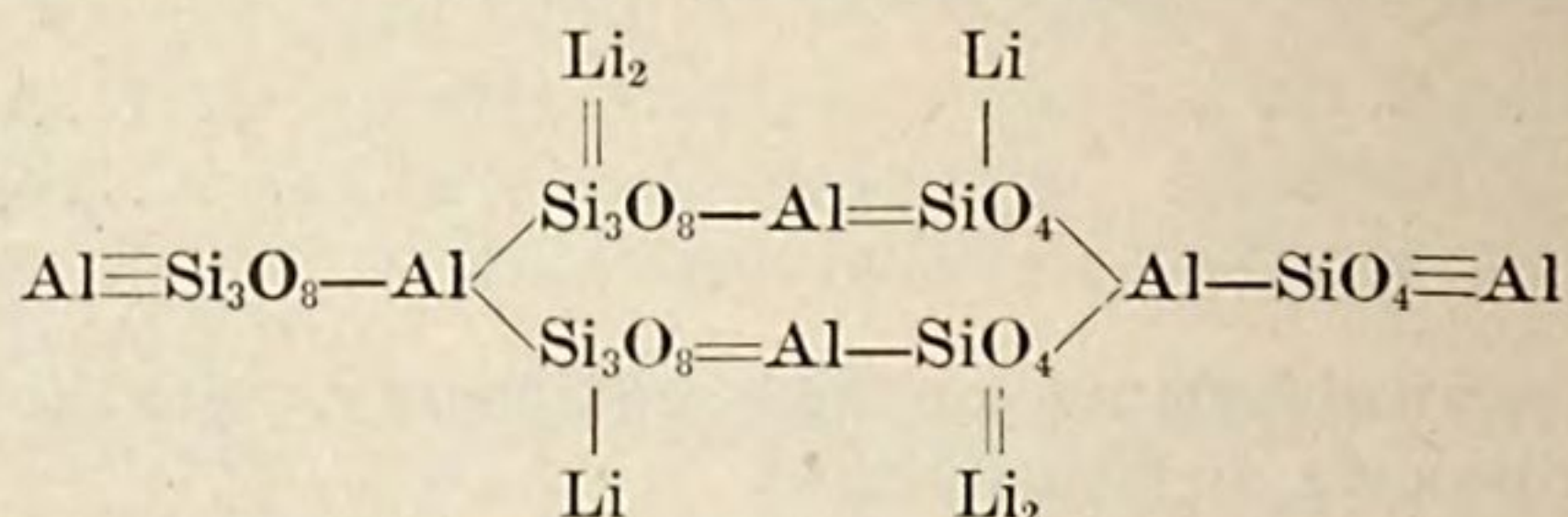
R'' being = Ca, Fe'' , and Mn. The ferric molecule is evidently equivalent to two acmite molecules, with Na_2 replaced by a linking atom of iron.

So far, except partially in the comparison between wollastonite and pectolite, the formulæ cited for the pyroxenes express composition and composition only. But spodumene, as shown by the elaborate research of Brush and Dana, splits upon alteration into a mixture of eucryptite, an orthosalt, and albite, a trisilicate. This observation suggests two alternatives: either that spodumene is derived from a polymetasilicic acid, or else that it is a pseudometasilicate, a mixed ortho- and tri-salt, like some of the species which have already been explained. An analogy with leucite, for example, will at once be inferred, and that species, empirically, is strikingly like spodumene, thus:

Leucite	AlKSi_2O_6
Spodumene	$\text{AlNaSi}_2\text{O}_6$

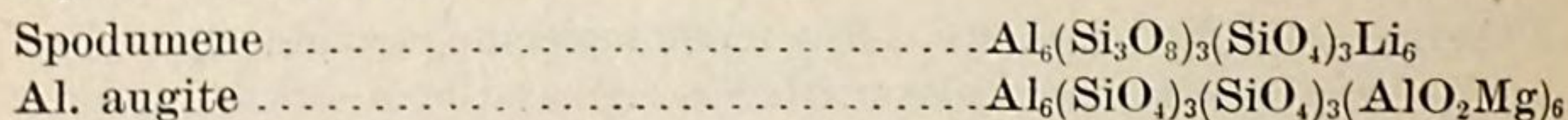
Like spodumene, leucite alters into a feldspar and a member of the nepheline group; but it differs from spodumene in form and in density. The specific gravity of the isometric leucite is 2.5, that of the monoclinic spodumene is nearly 3.2, and hence we may reasonably infer that the latter species has the larger and more condensed molecule. In order to explain the relations of leucite, its empirical formula was

quadrupled, and in that way a relation with the garnet group was brought out. For spodumene, regarding it also as a mixed silicate, a sixfold multiplication of its formula indicates its greater density, and its splitting up into eucryptite and albite, with partial replacement of lithium by sodium, is representable as follows:

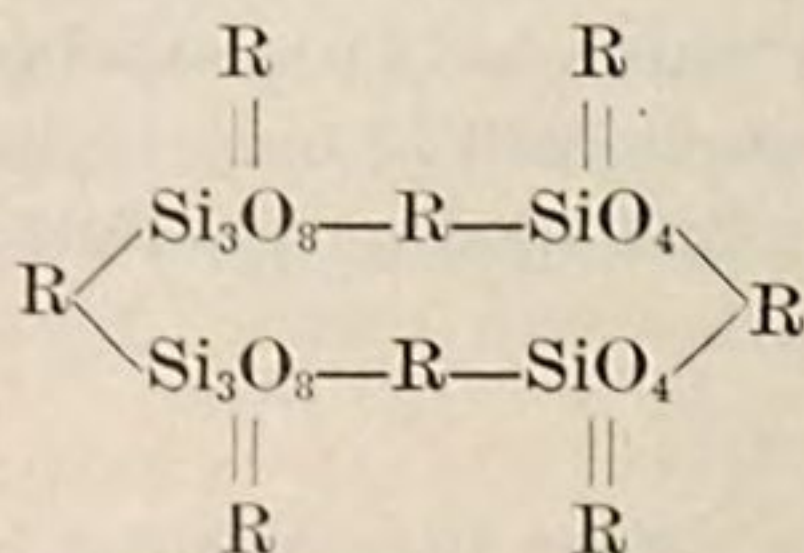


From this grouping of atoms the transition into $\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{Na}_3 + \text{Al}_3(\text{SiO}_4)_3\text{Li}_3$ is hardly more than a simple case of cleavage, and the relations between the three species are intelligibly expressed. Acmite, which yields pseudomorphs of analcite, and jadeite also, probably follow the same rule, the formula of one being typical of the others. The ferric molecule in babingtonite should be still another instance of the same kind, with Fe''_3 in place of Li_6 , and Fe''' instead of Al.

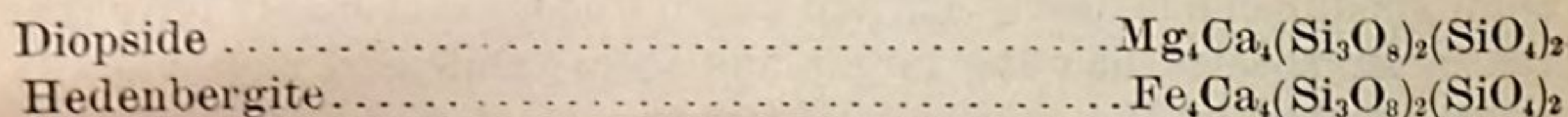
If the formula just developed for spodumene should be sustained, it would seem necessary to adjust the other pyroxenes with it. In the case of Tschermak's aluminous constituent of augite this adjustment is easily made by taking the formula $\text{Al}_2\text{MgSiO}_6$ six times, as in the case of spodumene. The parallelism between the two species is then representable as follows:



the univalent AlO_2Mg having been recognized among the micas. This formula serves to explain the well-known alterability of augite into epidote and into mica, and so far at least is useful. I do not, however, feel inclined to put very much stress upon it, for as yet it is only an expression of analogy, which may or may not prove to be valid. It would seem to require the recognition of all the pyroxenes as pseudo-metasilicates, in which case the normal series, containing only dyad bases, would become

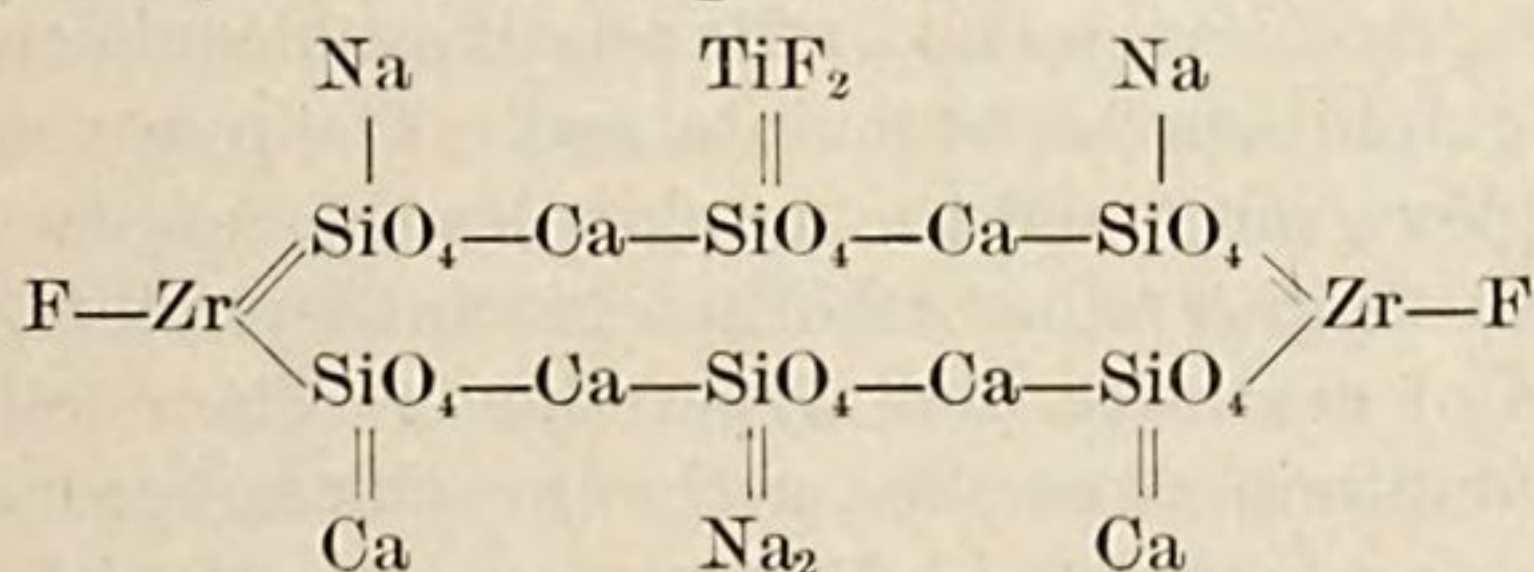


with four atoms of R given linking functions, while the other four are, so to speak, replaceably combined. On this basis we should write



The formula $R''_4(AlO)_8(SiO_4)_2(SiO_4)_2$ would be exactly parallel with these, and affords another expression for Tschermak's compound Al_2RSiO^6 . On the ground of simplicity this is preferable to the more complex expression based on the formula of spodumene.

The so-called "zircon pyroxenes," rosenbuschite, wöhlerite, lāvenite, and hiörtdahlite, I have already mentioned among the orthosilicates of zirconium. They can be given metasilicate ratios, following Brögger, by regarding the zirconium as present in the form of a metazirconate. If this explanation is correct, we should expect to find zirconates in nature, free from admixtures; but no such minerals are yet known. Artificial zirconates have, indeed, been prepared; but zirconium is more markedly basic than acid in its functions, and the analogy furnished by the orthosilicate, zircon, has been my guide in the interpretation of these species. Rosenbuschite, however, can be represented as a definite compound having structural analogies with the pyroxenes, as here formulated, with the composition



which compares well with Cleve's analysis,* thus:

	Found.	Calculated.
SiO ₂	31.36	30.30
ZrO ₂	20.10	20.54
TiO ₂	6.85	6.73
Fe ₂ O ₃	1.00	} 28.29
La ₂ O ₃	.33	
MnO.....	1.39	
CaO.....	24.87	
Na ₂ O.....	9.93	10.44
F.....	5.83	6.40
	101.66	102.70
Less O.....	2.47	2.70
	99.19	100.00

This mode of interpreting the pyroxenes is so remote from our usual conceptions that I bring it forward with great diffidence. It unifies the group, however, it expresses the observed alterations of the several species, and despite its complexity it will be found to be sustained and strengthened by evidence brought out in the study of the amphiboles.

This last-named group of highly important minerals resembles the pyroxenes in composition, and is explained by Tschermak in essentially the same way. Their molecular weights, however, are taken as double

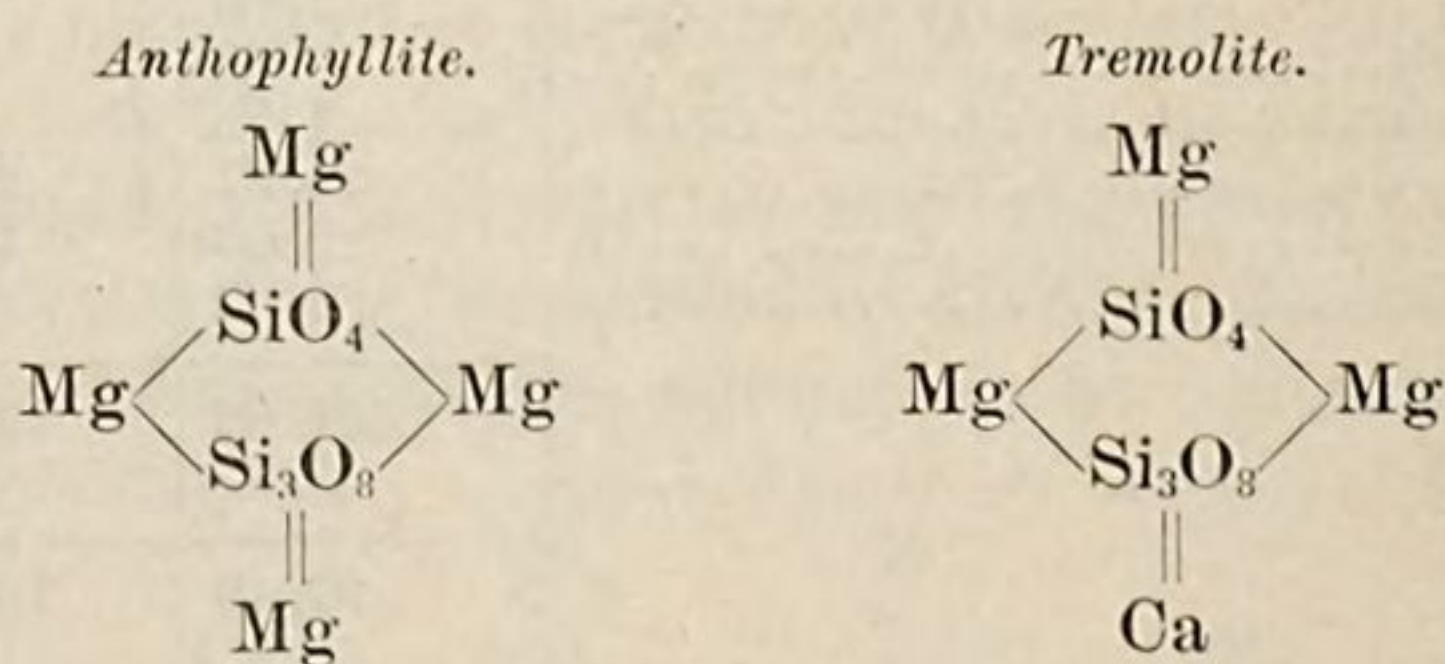
*Zeit. Kryst. Min., XVI, p. 383.

those of the pyroxenes, for the reason that the atomic replacements seem to occur by fourths rather than by halves. This point is exemplified by a comparison between diopside and tremolite; which, reduced to their simplest empirical formulæ, become

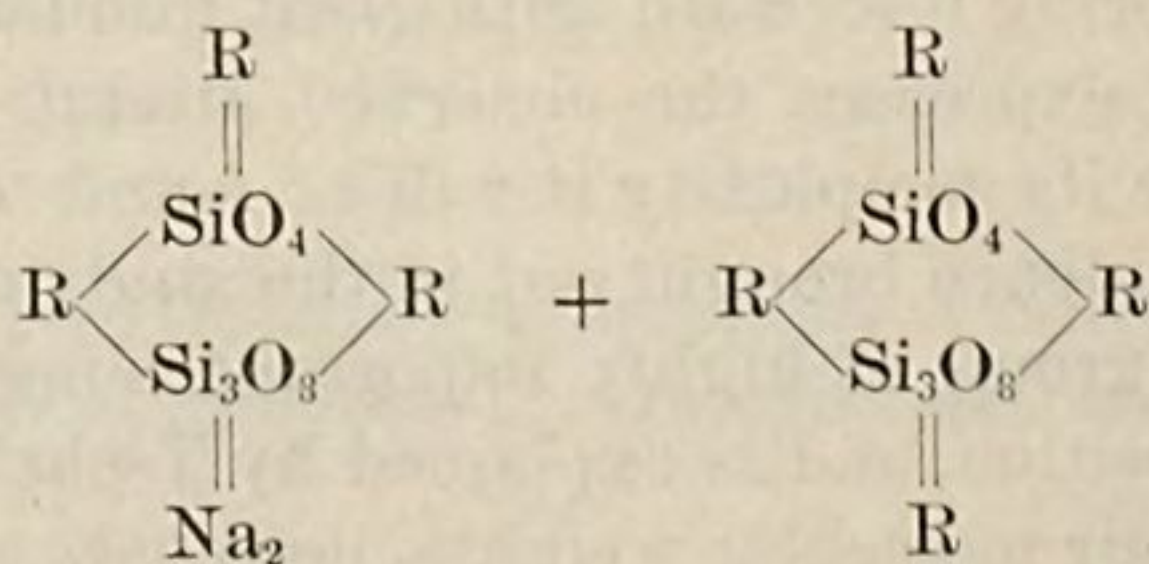
Diopside	$\text{CaMgSi}_2\text{O}_6$
Tremolite.....	$\text{CaMg}_3\text{Si}_4\text{O}_{12}$

The pyroxenes, however, are somewhat heavier than the amphiboles, and from their greater density we may suppose them to have the larger molecules. Hence the formula of diopside should be a multiple of that just cited, and presumably greater than $\text{Ca}_2\text{Mg}_2\text{Si}_4\text{O}_{12}$. Upon this point the phenomenon of uralitization has definite bearing. In this process pyroxene is converted into amphibole, with increase of volume and little or no change of composition. In other words, a complex molecule has been dissociated into simpler molecules—a phenomenon the direct opposite of polymerization. In the face of this evidence it is difficult to see how the current views as to the relative molecular magnitudes of pyroxene and amphibole can be maintained. The pyroxenes must form the more complex group, and the amphiboles the simpler.

In the amphibole group the orthorhombic anthophyllite is the equivalent or isomer of enstatite and hypersthene. Then follows a monoclinic series, containing tremolite, actinolite, cummingtonite, dannemonte, etc., all being represented by the general empirical formula RSiO_3 , with calcium, magnesium, iron, or manganese as the bivalent metal. In grünerite the salt FeSiO_3 exists by itself, and in richterite and astochite alkaline silicates appear. If we regard the minerals as pseudometasilicates, having molecular weights lower than the pyroxenes, and, with the bases replaceable by fourths, the typical amphiboles are most simply represented by formulæ like the following:

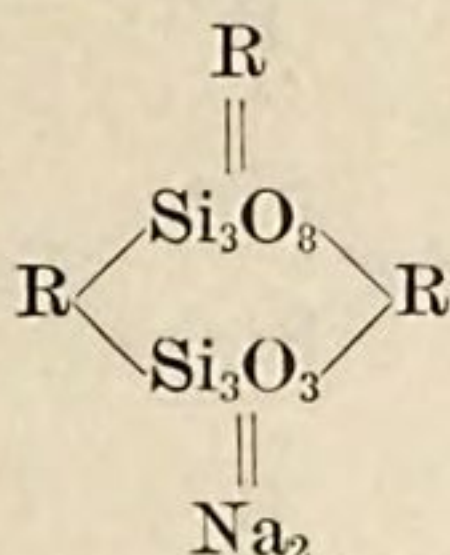


Richterite becomes a mixture of salts,



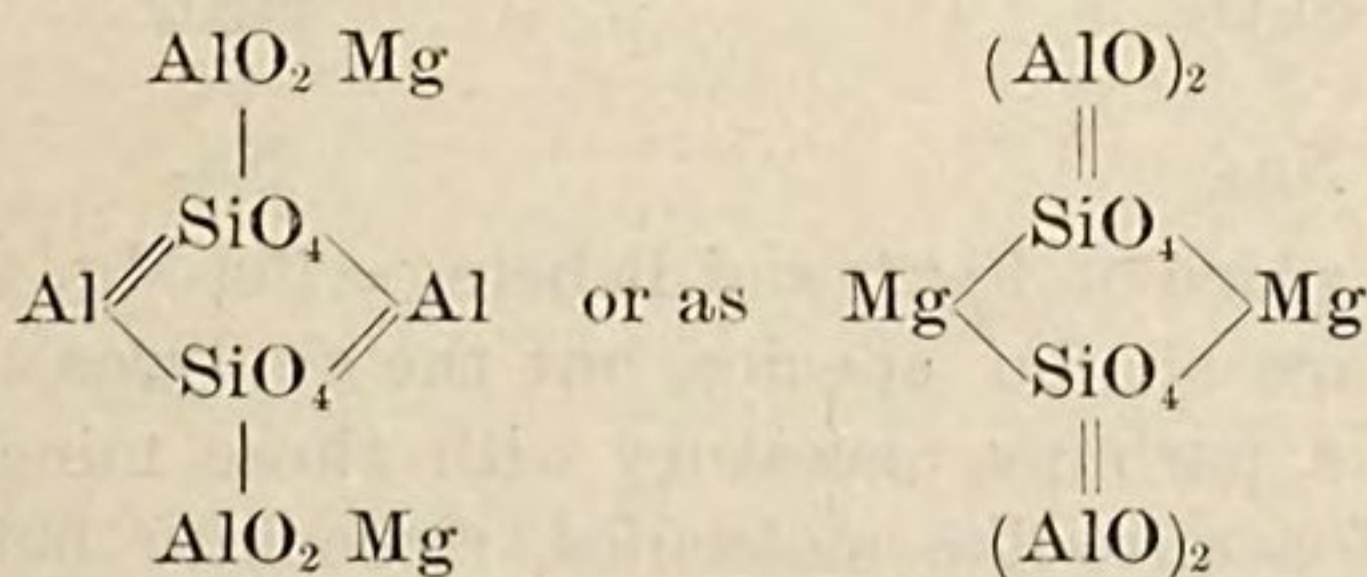
commingled in ratios near 1:1, and astochite is similar, but with NaH

in place of Na_2 . Potassium may also partly replace sodium. Another alkaline amphibole of doubtful character, waldheimite, approximates to



which is the formula of a trisilicate pure and simple, with $\text{R}=\text{Ca}$, Fe , Mg . The existence of this compound is strong evidence in favor of the pseudometasilicate theory; and, as will be seen later, it does not stand alone. The formulæ as written suggest a close analogy between the pyroxene-amphibole minerals and the olivine group, which may have some future significance.

Among the amphiboles, as among the pyroxenes, aluminous and ferric compounds are common, and with these the minerals approach to orthosilicate ratios. Tschermak's interpretation of these ratios is practically the same as in the pyroxene series, namely, by the assumption of molecules of the form Al_2RSiO_6 or $\text{Al}_4\text{R}_2\text{Si}_2\text{O}_{12}$. An alternative to this view is offered by Scharizer,* who shows that the hornblendes can be explained as mixtures of actinolite, $\text{R}_4\text{Si}_4\text{O}_{12}$, with an orthosilicate called syntagmatite $(\text{R}'_2\text{R}'')_3\text{Al}_2(\text{SiO}_4)_3$, whose ratios are similar to those of garnet. An amphibole from Jan Mayen's Island approaches very nearly to syntagmatite in composition. If a compound of this type is present in the amphiboles it would explain at once their alterability into epidote, micas, and chlorites; but so far as the composition of the group is concerned neither Tschermak's view nor Scharizer's is absolutely necessary. The Tschermakian molecule, however, can be written either as

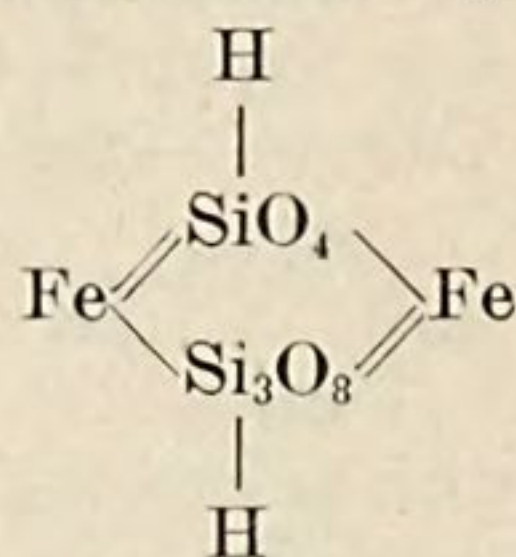


the latter form resembling that of tremolite, and also connecting the group still more closely with the olivines. It is also parallel to the last formula suggested for the corresponding pyroxene compound, being one-half of the latter and identical with it in type.

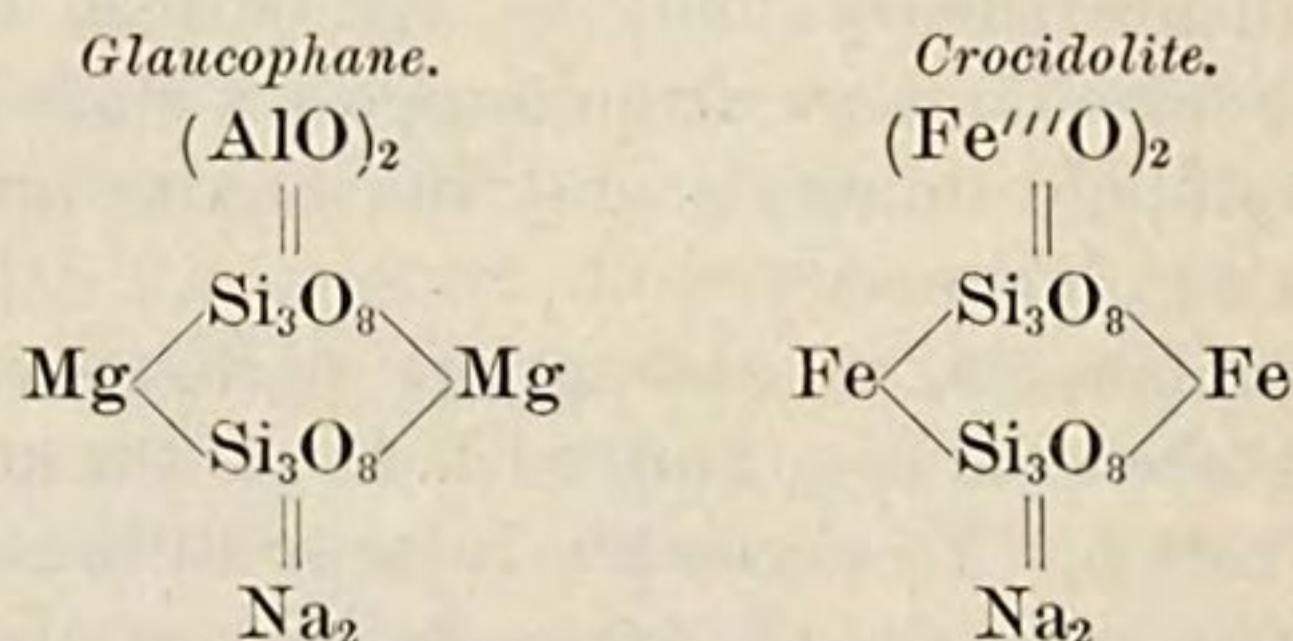
No amphibole is yet known which, by itself, corresponds precisely in its constitution to acmite and spodumene. In glaucophane we find a species, which, as a metasilicate, may be written $\text{AlNaSi}_2\text{O}_6 + (\text{MgFe})\text{SiO}_3$; and in crocidolite another similar salt, $\text{Fe}'''\text{NaSi}_2\text{O}_6 + \text{FeSiO}_3$. Crocidolite alters easily; and one of the products of alteration, which

* Neues Jahrbuch, 1884, (2), p. 143.

has been named griqualandite, is very near $\text{Fe}'''\text{HSi}_2\text{O}_6$, the equivalent of acmite in general type. This last compound can be written

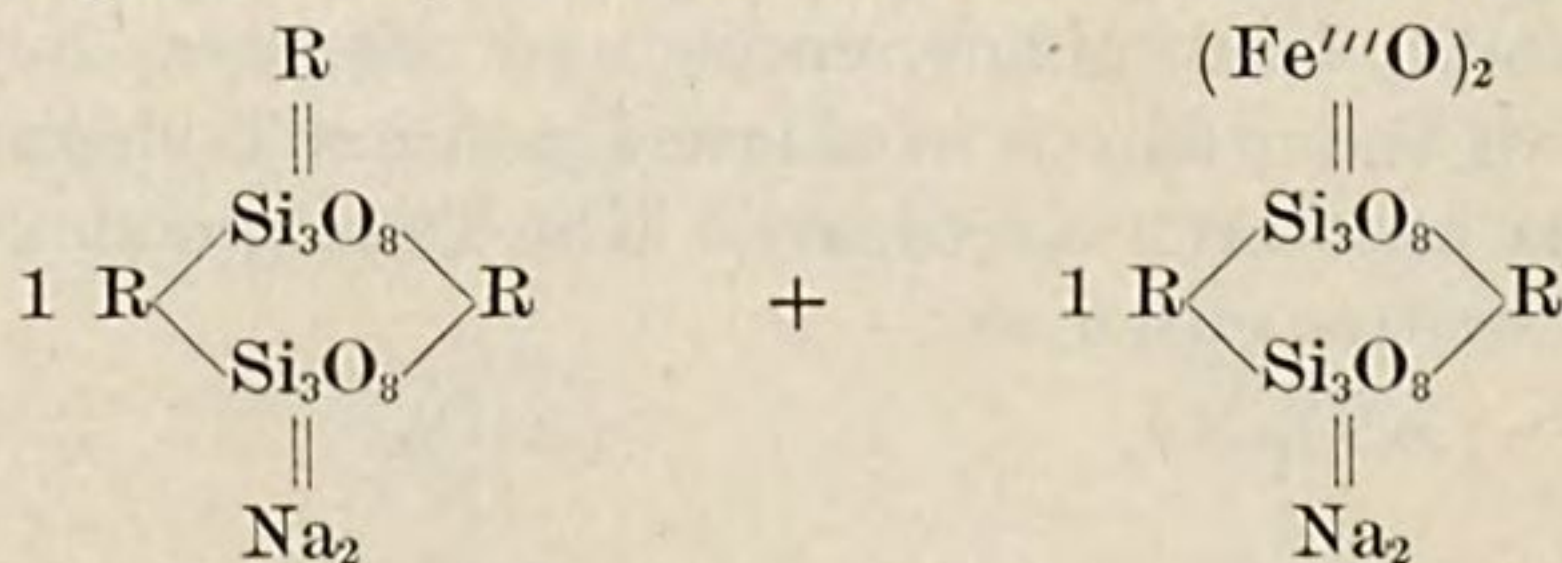


and so adjusted as an amphibole-hydrogen-acmite to the remainder of the group; but glaucophane and crocidolite are best formulated as follows:



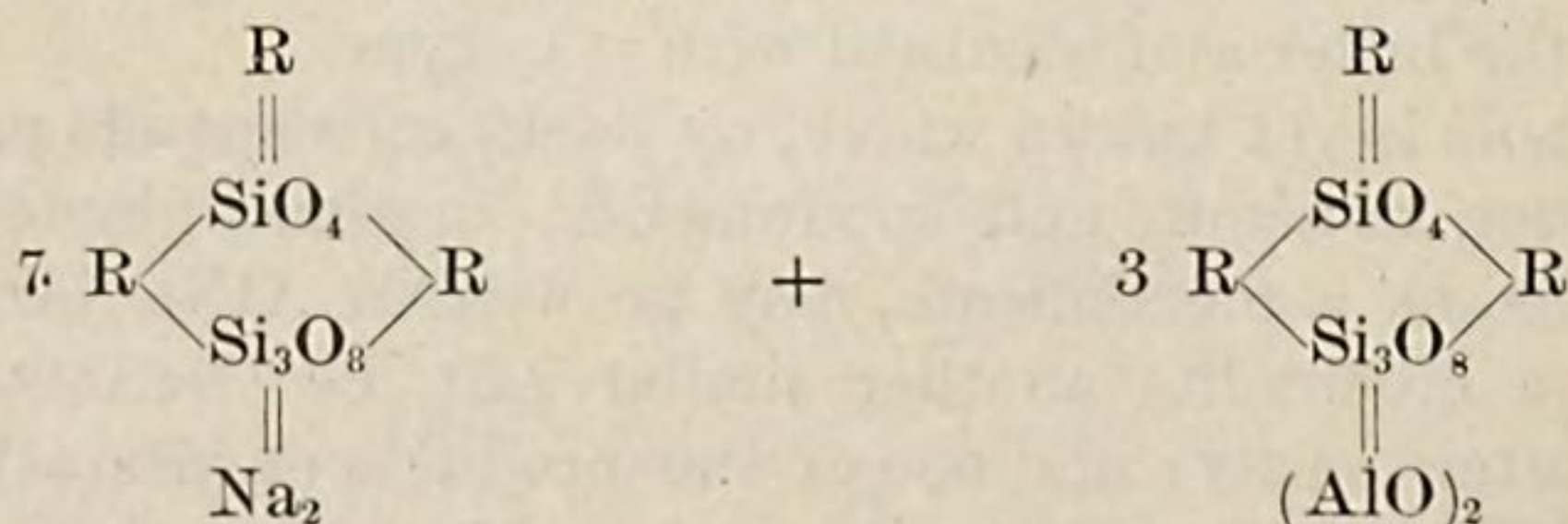
which makes them, as trisilicates, precisely equivalent in structure to the normal amphiboles. These compounds, and their corresponding orthosilicates, commingled with salts like tremolite or actinolite, give mixtures which conform in composition to the aluminous hornblendes.

Closely allied to crocidolite and glaucophane is the recently described amphibole crossite;* in which the ratio of Si:O is distinctly less than 1:3. This species may be written as a mixture of the two molecules



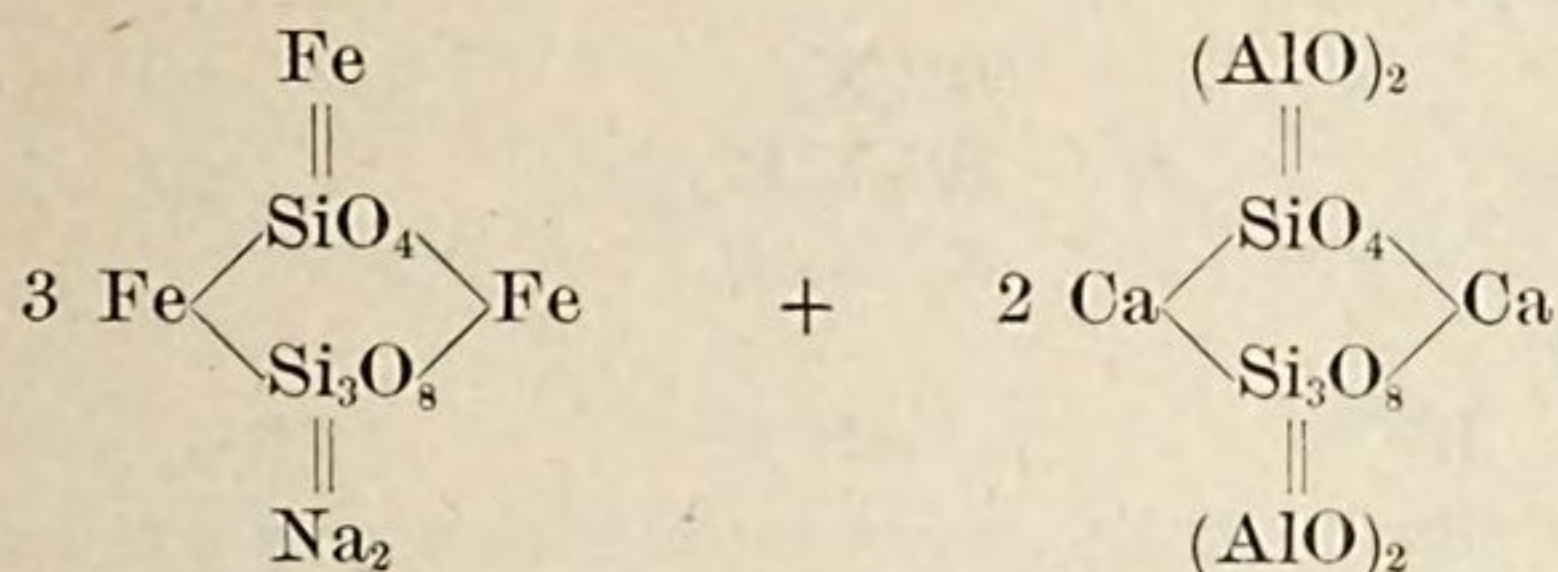
with some Al in place of Fe''' , and R being = Fe, Mg, Ca. Gastaldite and riebeckite are similar species, but the analyses are not perfectly conclusive. It is, perhaps, necessary with these minerals to assume the presence of acmite-like molecules, riebeckite being empirically near $2\text{Fe}'''\text{NaSi}_2\text{O}_6 + \text{FeSiO}_3$.

Arfvedsonite, in which R' is mainly Fe, may be represented quite closely as a mixture of this order:

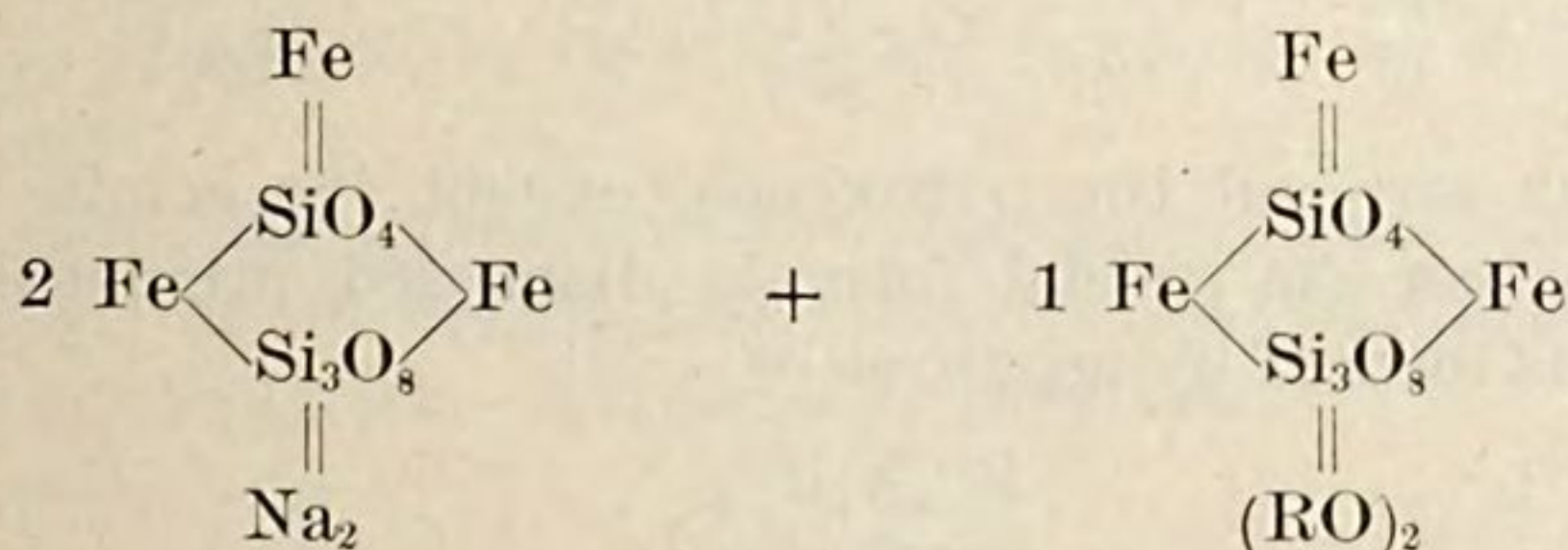


* Palache, Geol. Bulletin, Univ. of California, I, p. 181. 1894.

a little aluminum being replaced by iron. Barkevikite, a more basic species still, has its composition well indicated by the following expression, with some Fe replacing Al as in arfvedsonite:



Finally, in the triclinic aenigmatite, if we assume that the titanium (7.57 per cent TiO_2) is equivalent to silica, we find the mixture



with $\text{RO} = \text{AlO}:\text{FeO}::1:1$ almost exactly, and $\text{Si}:\text{Ti}::7:1$. Calculating with these ratios, aenigmatite has the following composition in comparison with Forsberg's analysis:*

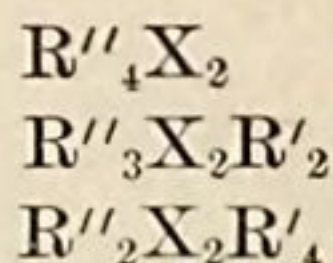
	Found.	Calculated.
SiO_2	37.92	38.11
TiO_2	7.57	7.26
Fe_2O_3	5.81	4.85
Al_2O_3	3.23	3.08
FeO	35.88	39.20
MnO	1.00	
CaO	1.36	
MgO	.33	7.50
Na_2O	6.58	
K_2O	.51	
	100.19	100.00

The variations here are plainly due to the replacements of Fe by Mn, Ca, and Mg, and of Na by K.

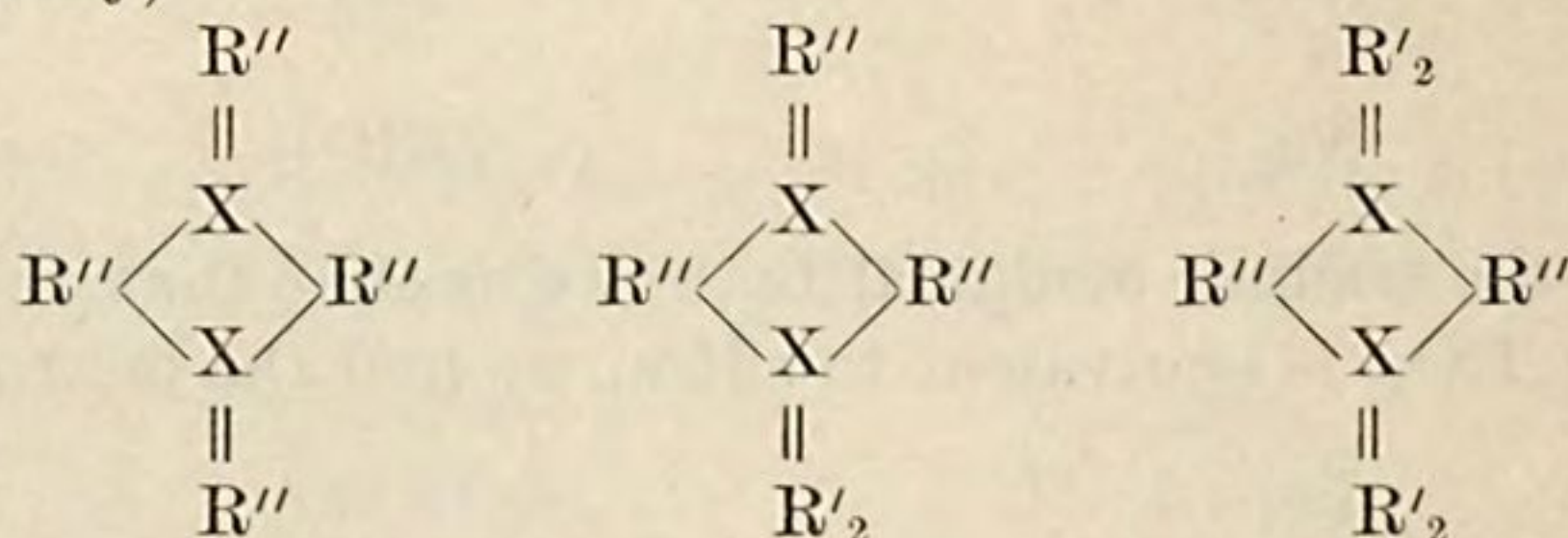
A careful study of the best analyses in the pyroxene and amphibole groups will strengthen very materially the view here developed that the species are not true metasilicates. Although in most cases the approximation to metasilicate ratios is very close, there are distinct variations toward orthosilicates on one side and toward trisilicates on the other, and it is only by assuming that we have mixed silicates to deal with that all the anomalies can be made to disappear. On this

*Zeit. Kryst. Min., XVI, p. 428.

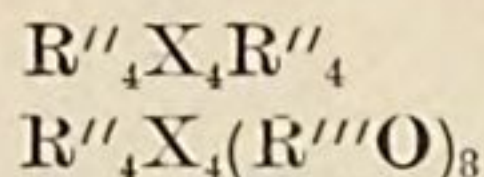
theory, if we represent Si_3O_8 and SiO_4 groups indiscriminately by the general symbol X , all of the amphiboles are covered by the following typical symbols, in which R'' stands for any dyad metal, and R' for K, Na, H, AlO, or $\text{Fe}'''\text{O}$:



or, structurally,

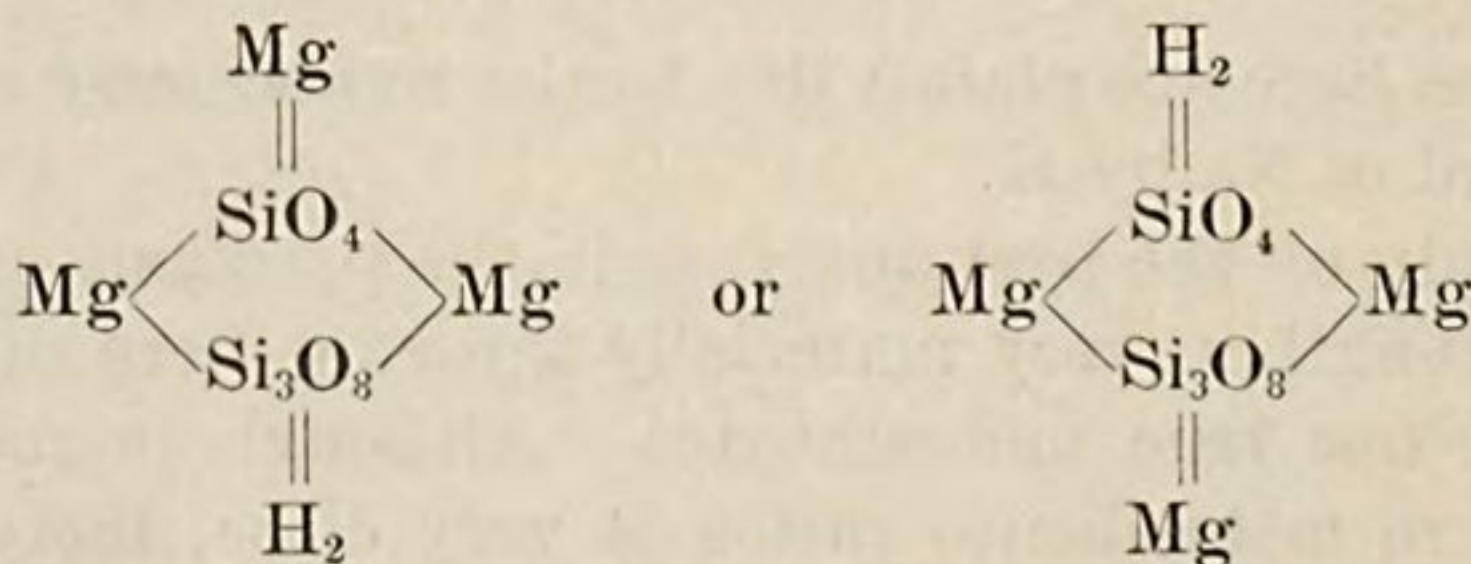


In a similar way, all the pyroxenes, except the acmite-spodumene group, which has the special formula discussed previously, may be represented as formed by mixtures of



which is in accordance with the theory developed by Tschermak except as to the molecular magnitude of the compounds—that is, the pyroxenes are essentially bipolymers of the amphiboles, and the character of the structure is the same for both groups. The olivine minerals are represented by similar orthosilicate formulæ, $R_4(\text{SiO}_4)_2$ being the constitutional equivalent of $R_4(\text{SiO}_4)(\text{Si}_3\text{O}_8)$. Pseudomorphs of pyroxene (fassaite) after monticellite, have been found at Monzoni, and are well known. Furthermore, Becke* has described pseudomorphs of anthophyllite and actinolite after olivine, so that a connection between the two groups is clearly indicated. The tracing of this connection in a more general way would seem to offer a profitable field for investigation.

By the hydration of pyroxene or amphibole either serpentine or talc may be generated. The latter species has the composition $\text{H}_2\text{Mg}_3\text{Si}_4\text{O}_{12}$, and may be written structurally like amphibole either

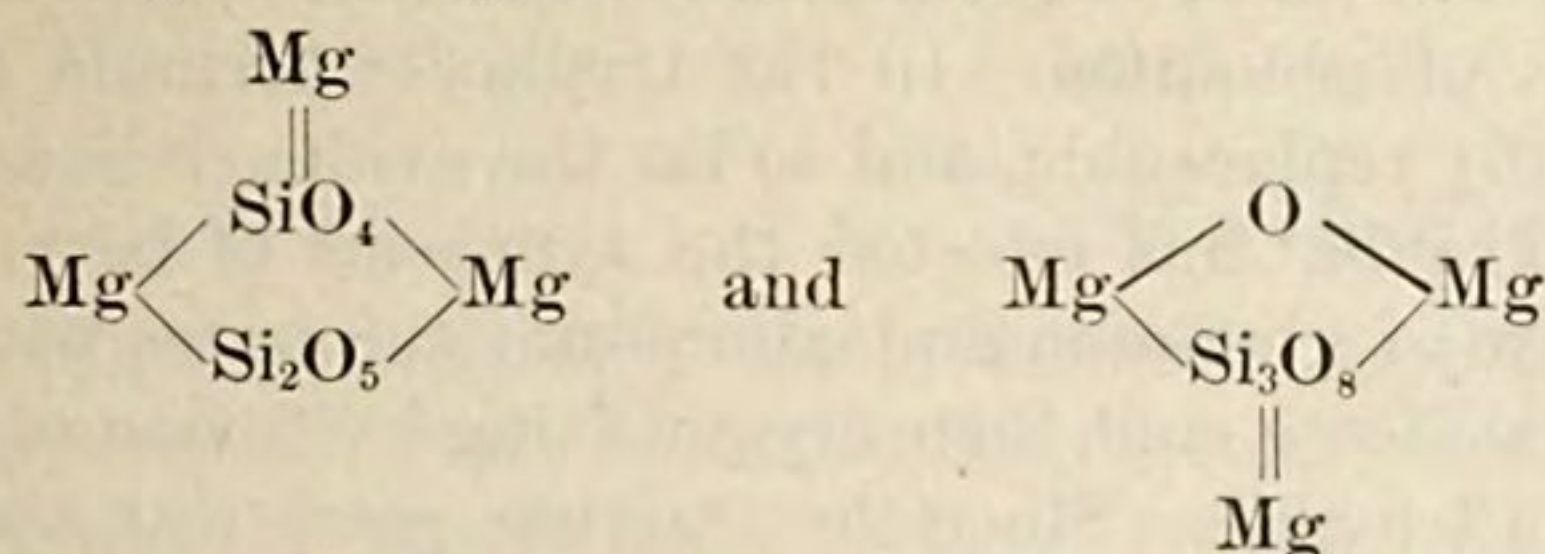


Both expressions are in accord with the fact recorded by Schneider and myself,† that upon the ignition of talc one-fourth of the silica is

* Min. Pet. Mitth. (N. F.), 4, pp. 355 and 450.

† Bull. U. S. Geol. Survey No. 78, p. 13.

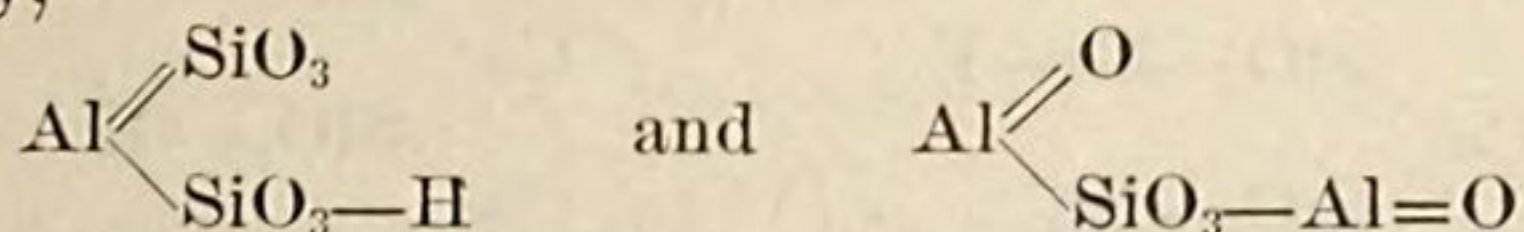
set free quantitatively. This would give the ignited residue the composition shown by the subjoined alternative formulæ:



and of these the first would seem to accord the better with the remarkable stability and insolubility of the material. A metasilicate formula, $\text{H}_2\text{Mg}_3(\text{SiO}_3)_4$, is also admissible, and accords equally well with the evidence concerning talc. The pseudometasilicate expression, however, seems to be preferable in view of what is known as to the genesis of the species.

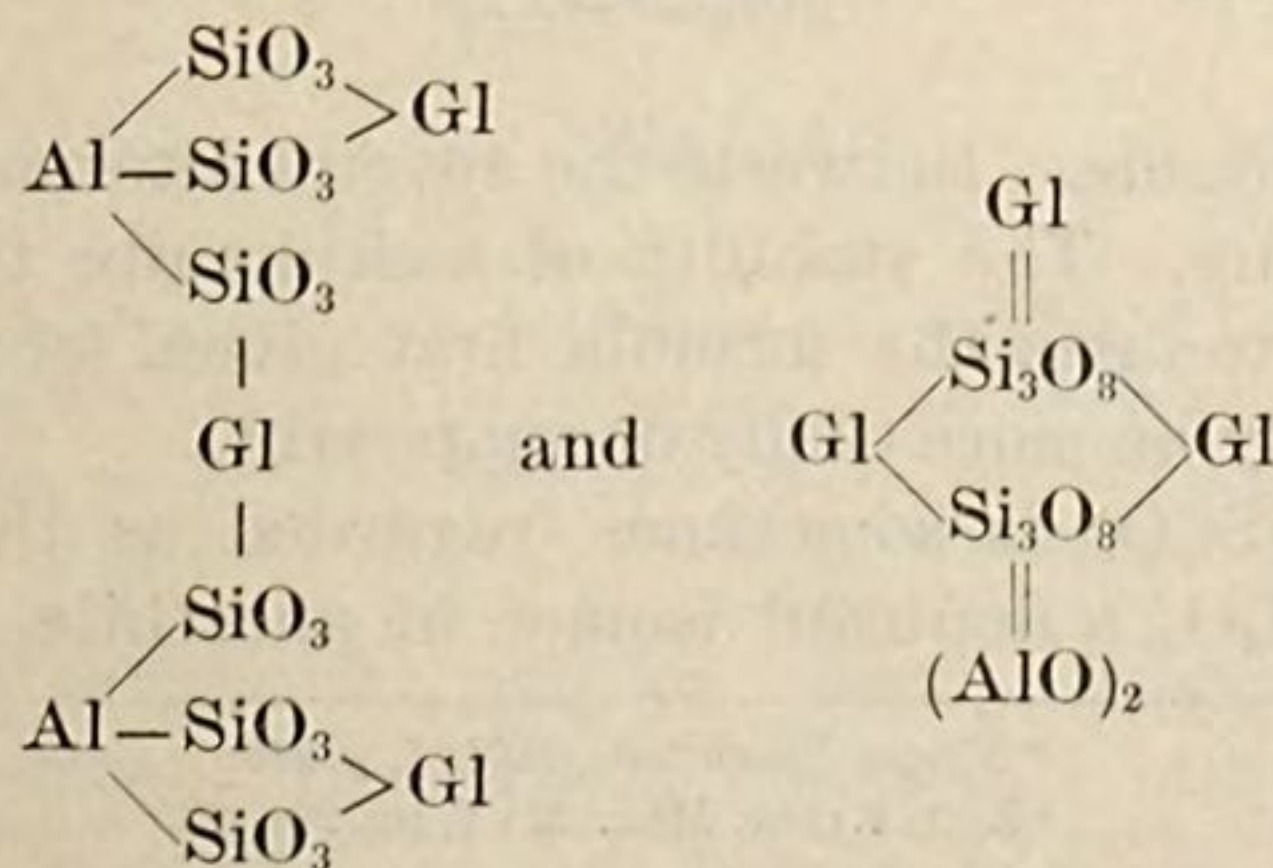
Pyrophyllite and kyanite are two aluminous metasilicates which seem to be related; at all events the former is not infrequently the gangue or matrix of the latter. Empirically they are

Pyrophyllite AlHSi_2O_6
 Kyanite Al_2SiO_5
 or, structurally,



To these formulæ I attach very little significance, except in so far as they represent a single observed relation. Probably the true formulæ should be multiples of these; for kyanite is much denser than its isomer, andalusite, $\text{Al}_3(\text{SiO}_4)_3(\text{AlO})_3$. Both kyanite and andalusite, at very high temperatures, are transformed, with disengagement of heat, into a third isomer, sillimanite,* a phenomenon which indicates dissociation. Sillimanite doubtless has the smallest molecule of the three species, and may be $\text{Al}\equiv\text{SiO}_4\text{—AlO}$, but even this is so purely hypothetical that it would be useless at present to discuss the species farther.

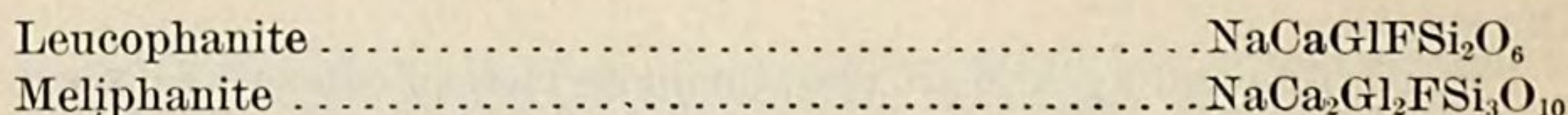
With beryl, $\text{Gl}_3\text{Al}_2\text{Si}_6\text{O}_{18}$, the evidence in favor of a metasilicate structure is fairly good, although the composition can also be expressed as that of a basic trisilicate. There are thus two alternatives,



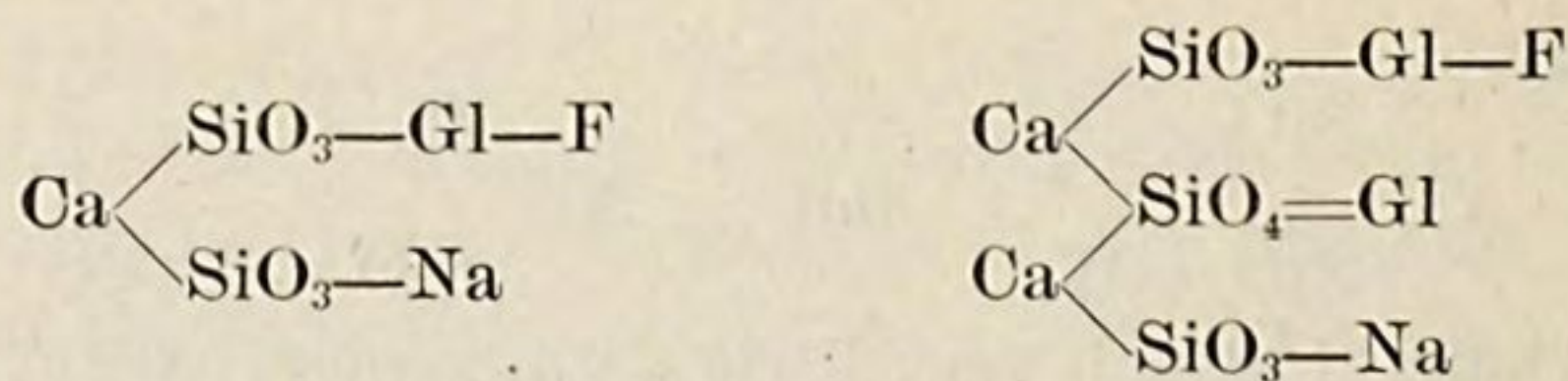
* Vernadsky, Bull. Soc. Min., XII, p. 447, and XIII, p. 256.

But beryl alters into mica, a fact which is favorable to the first of these formulæ, and all of its commoner alterations seem to take place by replacement of glucinum. In the trisilicate formula the alumina should be equally replaceable, and so far the evidence is adverse to it. Furthermore, Traube* has effected the synthesis of beryl by precipitating a mixture of glucinum and aluminum sulphates with a solution of sodium metasilicate, and then crystallizing by fusion of the precipitate with boron trioxide. Since the starting point was a metasilicate, there is a fair presumption that the product was a metasilicate also. Beryl can be written as a pseudometasilicate, but there are no data to justify doing so.

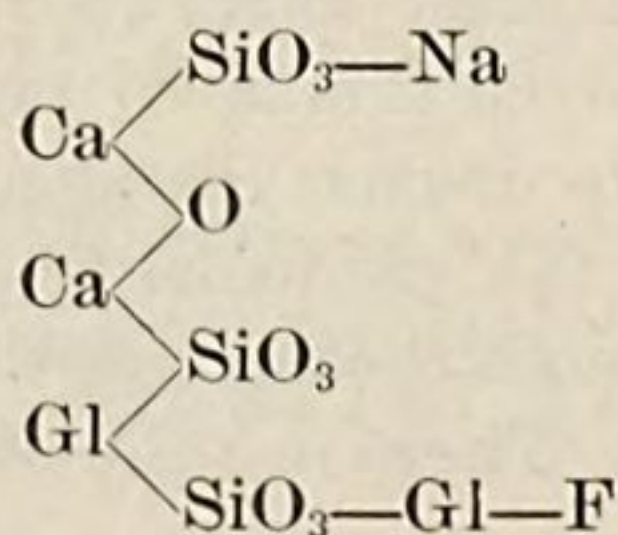
Two other minerals containing glucinum, leucophanite, and meliphanite, appear to be essentially metasilicates with the subjoined formulæ:



These are capable of several interpretations. The simplest regards meliphanite as a mixed meta- and orthosilicate, when both species can be written



or else with the glucinum as the linking element, and with the calcium united to fluorine. This involves no change of type, but only an exchange of position between Ca and Gl. Brögger,† to whom the empirical formulæ are due, also represents meliphanite as a basic metasilicate



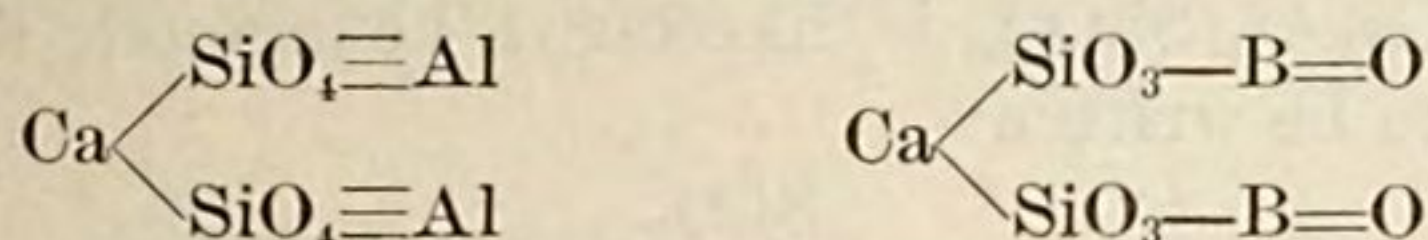
which is also justifiable. Between the several alternatives there is no ground for deciding. The stability of meliphanite toward ordinary acids would seem to favor the formula first given, for a basic calcium salt would probably be more easily decomposable.

Danburite, $\text{CaB}_2\text{Si}_2\text{O}_8$, is sometimes regarded as the equivalent of barsowite, $\text{CaAl}_2\text{Si}_2\text{O}_8$, a doubtful isomer of anorthite. But barsowite

* Neues Jahrbuch., 1894, I, p. 275.

† Zeit. Kryst. Min., XVI, pp. 289-291.

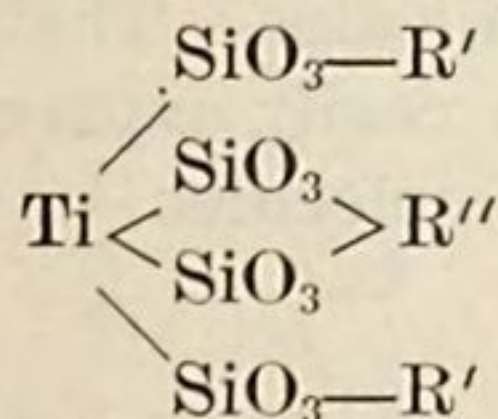
gelatinizes with hydrochloric acid, while danburite is attacked by the reagent only after ignition. Possibly the difference may be as follows:



danburite being a metasilicate. Other formulæ are also possible, and more data are needed before any conclusion can be reached. The associations of danburite with feldspars, mica, pyroxene, etc., suggest that it may be a pseudometasilicate, allied in structure to the aluminous constituent of augite.

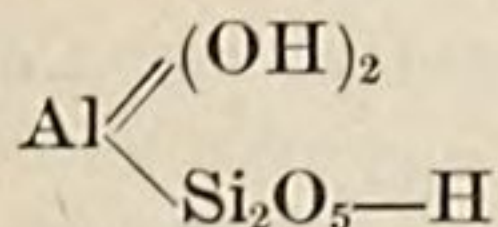
Chrysocolla is probably a metasilicate, and perhaps, empirically, $\text{CuSiO}_3 \cdot 2\text{H}_2\text{O}$. It can not be well regarded as impure diopside, for the latter gelatinizes with hydrochloric acid, while chrysocolla does not. The species, which may be a mixture of compounds, needs careful investigation.

Among the titanosilicates, the recently described neptunite* appears to be a meta compound,



with $\text{R}' = \text{Na}, \text{K}$, and $\text{R}'' = \text{Fe}, \text{Mn}$. The analogy between this formula and the formulæ of the titanium orthosilicates is its sole justification. The ratios given by analysis, however, are sharply in accord with the proposed expression.

The salts which are fairly ascribable to dimetasilicic acid, $\text{H}_2\text{Si}_2\text{O}_5$, are few in number and comparatively rare. Among them, petalite, $\text{AlLi}(\text{Si}_2\text{O}_5)_2$, is the best known and most characteristic. Its formula, as here written, is closely similar to the metasilicate formula for spodumene, and the two species are commonly associated. Petalite, however, has far the lower density of the two, and is therefore presumably composed of smaller molecules. An alteration product of petalite, hydrocastorite, approximates roughly to



which requires

SiO_2	60.60
Al_2O_3	25.75
H_2O	13.65
	100.00

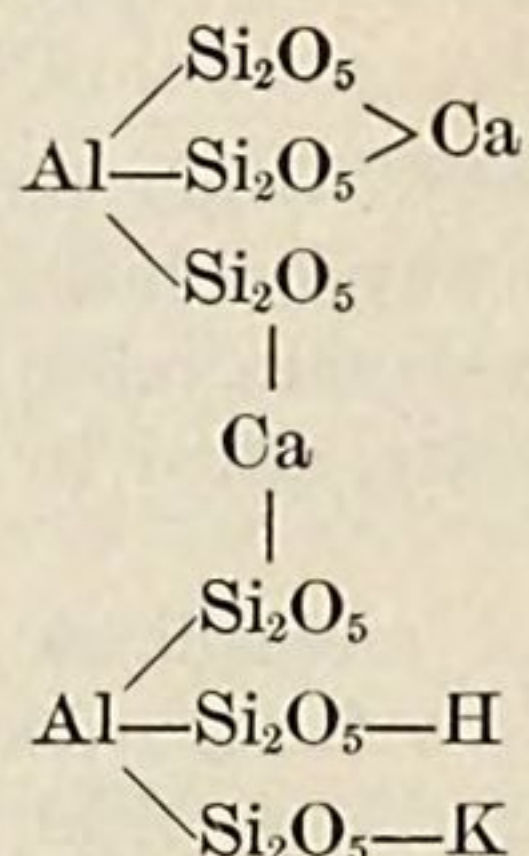
The actual hydrocastorite contains about 4.3 per cent of lime, and is doubtless impure. By Doelter† petalite is interpreted somewhat

* Flink. Geol. Fören. Förhandl., XV, p. 196.

† Min. Pet. Mitth., 1878, I, p. 529.

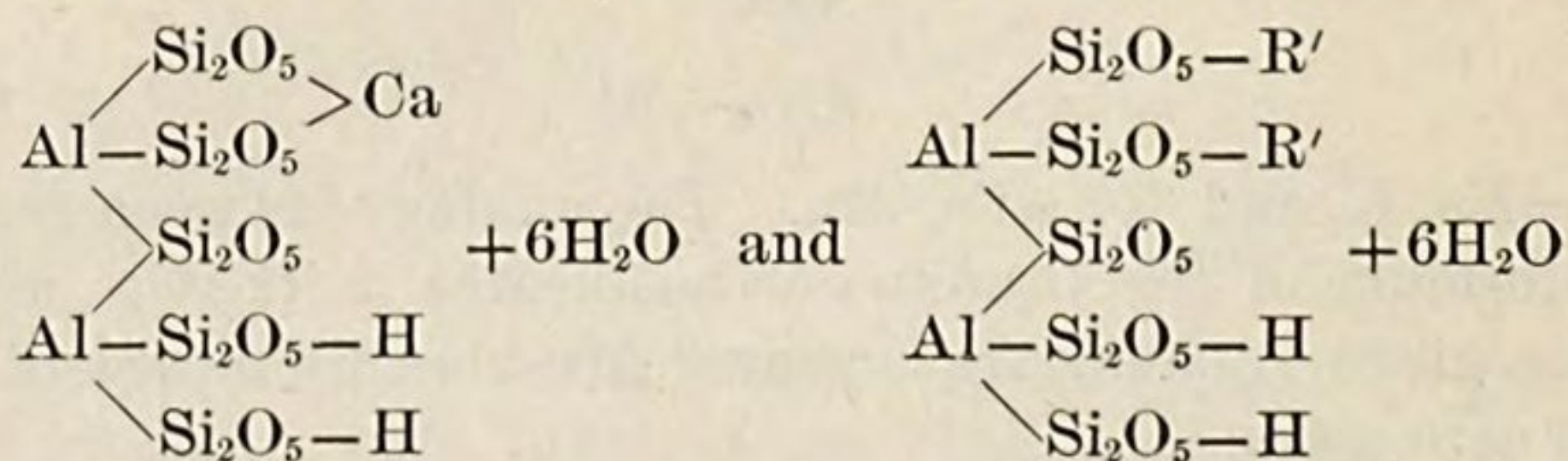
differently, being given the empirical formula $\text{Al}_2\text{Li}_2\text{Si}_{10}\text{O}_{24}$; but the formula here adopted is the one most generally received.

Milarite, $\text{HKCa}_2\text{Al}_2(\text{Si}_2\text{O}_5)_6$, is, like beryl, hexagonal; and its formula is analogously to be written



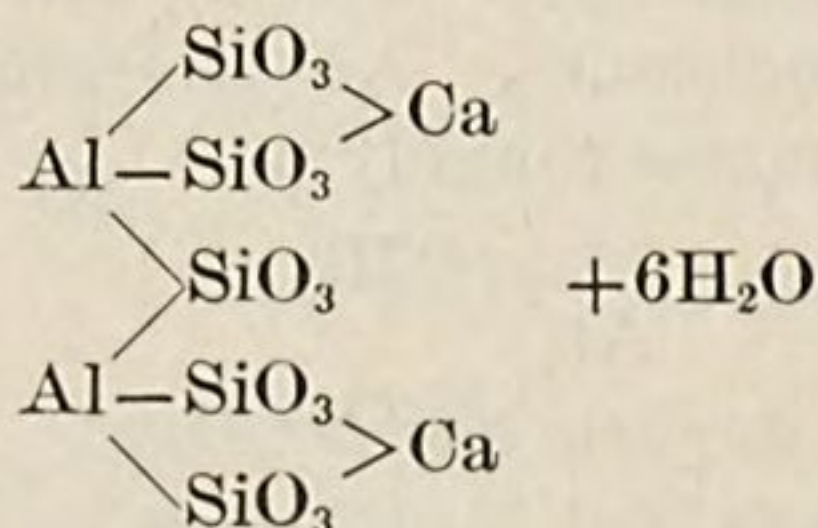
For this species the only evidence is that of its composition. Its genesis and its possible alterations are unknown.

The two closely allied zeolitic minerals, mordenite and ptilolite, are also to be classed as dimetasilicates. Their constitution, which I have fully discussed elsewhere,* is easily expressed by regarding both minerals as mixtures of the two molecules



in which $\text{R}' = \text{Na}$ or K . In one occurrence of ptilolite the water is lower than is required by these formulæ, and it seems probable that a trihydrate may exist.

The metasilicate zeolite, laubanite, is the precise equivalent of ptilolite and mordenite, and is easily interpreted thus:

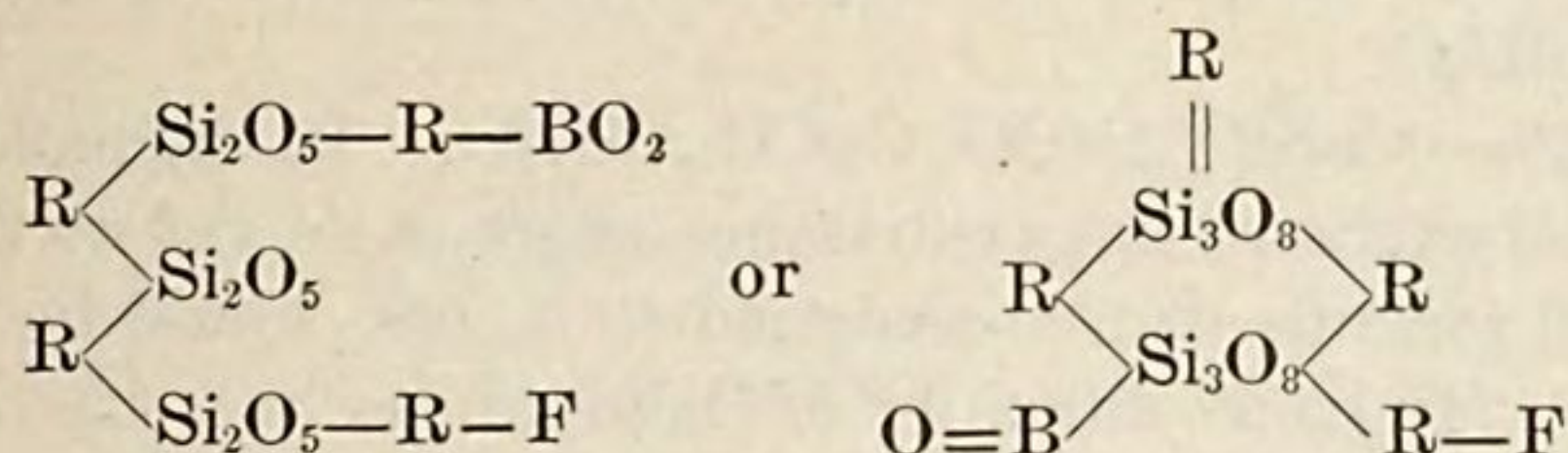


Pilinite, a similar mineral, seems to be $\text{Al}_2(\text{SiO}_3)_5\text{Ca}_2\cdot\text{H}_2\text{O}$, a monohydrate corresponding to the hexhydrated laubanite. Unlike laubanite, pilinite is undecomposed by hydrochloric acid; but physically all four of the species here grouped together resemble one another very closely.

The rare mineral hyalotekite, which contains boron, agrees very closely with the empirical formula $\text{R}''_4\text{BFSi}_6\text{O}_{17}$, if we regard the water

* Am. Jour. Sci., August, 1892.

in it as hydroxyl replacing fluorine. This can be interpreted either as a dimetasilicate or as a trisilicate, with the following alternative formulæ:



Its association with feldspar and schefferite rather favors the trisilicate formula, but the two are empirically identical. If we reduce Lindström's analysis to 100 per cent, after calculating the water (ignition) into its equivalent of fluorine, rejecting as impurities the traces of Al_2O_3 and Fe_2O_3 , and consolidating like bases, we get the following comparison with theory:

	Found.	Reduced.	Calculated.
SiO_2	39.47	38.60	38.10
B_2O_3	3.73	3.63	3.71
PbO	25.11	25.71	26.22
CuO	.09		
MnO	.29		
GlO	.75		
Na_2O	.17		
CaO	7.82	9.43	9.22
BaO	20.08	21.32	21.59
MgO	.09		
K_2O	.89		
Al_2O_3	.18	.....	.....
Fe_2O_3	.06	.....	.....
F	.99		
Cl	.06	2.26	2.01
Ign	.59		
	100.37	100.95	100.85
Less O		.95	.85
		100.00	100.00

In computing, R'' has been regarded as $\text{Ca}:\text{Ba}:\text{Pb}::7:6:5$ —that is, hyalotekite is a mixture of isomorphous calcium, barium, and lead salts in the indicated ratio. The agreement between analysis and theory is as close as could be reasonably expected.

There still remain a few natural silicates which are definitely recognized as species, but which do not fall distinctly into any one of the chapters of this work. Their constitution is obscure, and I shall not attempt to discuss them. Still, they may properly be recorded at this point for the sake of completeness.

Cuspidine.—A fluosilicate of calcium, supposed to be orthosilicate in structure. It may be allied to chondrodite, but it has not yet been completely analyzed.

Långbanite.—A silicate of manganese and iron containing antimony. Allied on crystallographic grounds to the oxides hematite and ilmenite.

Uranophane.—Composition represented by the empirical formula $\text{CaU}_2\text{Si}_2\text{O}_{11} \cdot 6\text{H}_2\text{O}$.

Thaumasite.— $\text{CaSiO}_3, \text{CaSO}_4, \text{CaCO}_3, 15\text{H}_2\text{O}$. To the molecular constitution of this extraordinary substance there is as yet no tangible clew. A structural formula can be assigned to it, but would be meaningless.

Neotocite.—Hydrous silicates of manganese and iron, of variable composition. Several distinct compounds are probably covered by this name.

A multitude of other silicates have been described as species, but without, as yet, securing full recognition. Some of these are doubtless mixtures, or impure varieties of well known minerals; while others may be ultimately established as good and definite compounds. A discussion of the records, without experimental investigation of the various minerals, would have very uncertain value. I therefore omit these doubtful species from consideration.

CHAPTER VIII.

SUMMARY.

The formulæ developed in the body of this memoir are so varied and so interlinked, one with another, that a summary of them in concise form seems to be desirable. I accordingly append such a summary, with occasional notes intended to make the subject, if possible, more clear.

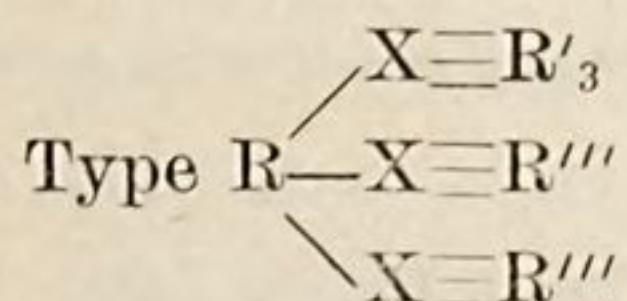
1. *Ortho- and trisilicates of triad bases.*

A. Normal salts.

Xenolite	$\text{Al}_4(\text{SiO}_4)_3(?)$
Samoite	$\text{Al}_4(\text{SiO}_4)_3 \cdot 10\text{H}_2\text{O}(?)$
Cimolite	$\text{Al}_4(\text{Si}_3\text{O}_8)_3 \cdot 6\text{H}_2\text{O}(?)$
Anthosiderite	$\text{Fe}_4(\text{Si}_3\text{O}_8)_3 \cdot 2\text{H}_2\text{O}(?)$
Pseudobrookite	$\text{Fe}_4(\text{TiO}_4)_3$
Eulytite	} $\text{Bi}_4(\text{SiO}_4)_3$
Agricolite	

Of these species the last three are definitely established, but the others are more or less uncertain.

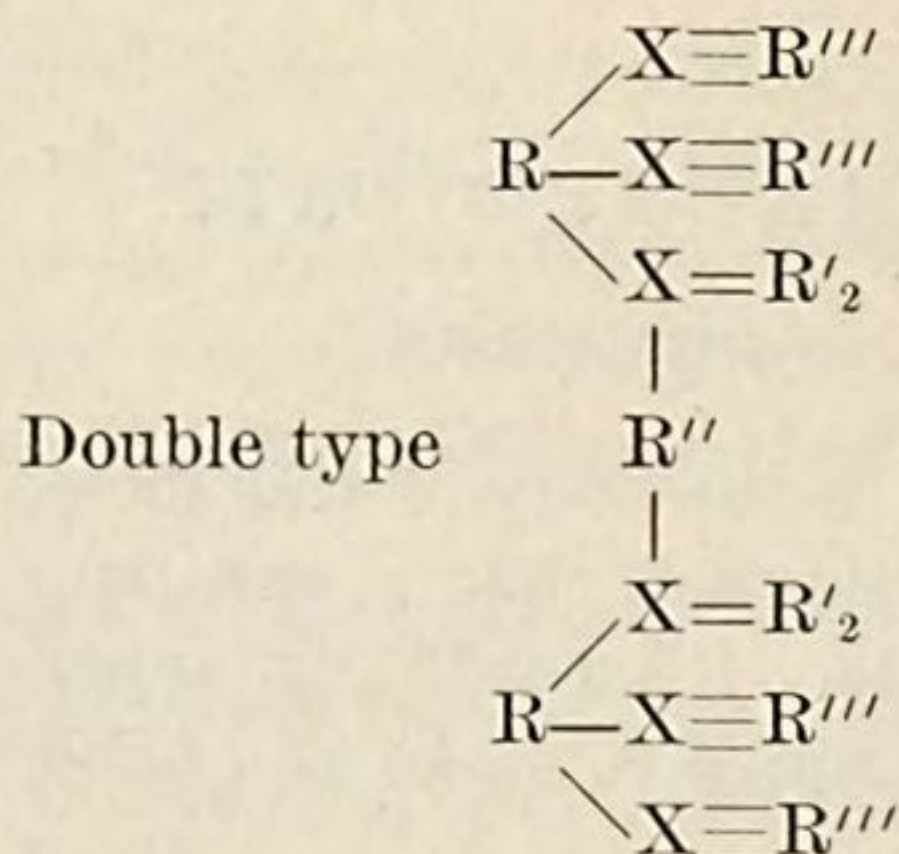
B. First substitution series.



Eucryptite	$\text{Al}_3(\text{SiO}_4)_3\text{Li}_3$
Nephelite	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_3$
Kaliophilite	$\text{Al}_3(\text{SiO}_4)_3\text{K}_3$
Kryptotile	$\text{Al}_3(\text{SiO}_4)_3\text{H}_3(?)$
Albite	$\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{Na}_3$
Orthoclase	$\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{K}_3$
Paragonite	$\text{Al}_3(\text{SiO}_4)_3\text{NaH}_2$
Muscovite	$\text{Al}_3(\text{SiO}_4)_3\text{KH}_2$
Andalusite	} $\text{Al}_3(\text{SiO}_4)_3(\text{AlO})_3$
Sillimanite	
Topaz	$\text{Al}_3(\text{SiO}_4)_3(\text{AlF}_2)_3$
Kornerupine*	$\text{Al}_3(\text{SiO}_4)_3(\text{AlO}_2\text{Mg})_3$
Rectorite	$\text{Al}_3(\text{SiO}_4)_3\text{H}_3 \cdot 2\text{H}_2\text{O}(?)$
Hydronephelite	$\text{Al}_3(\text{SiO}_4)_3\text{Na}_2\text{H} \cdot 3\text{H}_2\text{O}$

* Doubtful. Compare with formulæ given for pyroxenes and amphiboles.

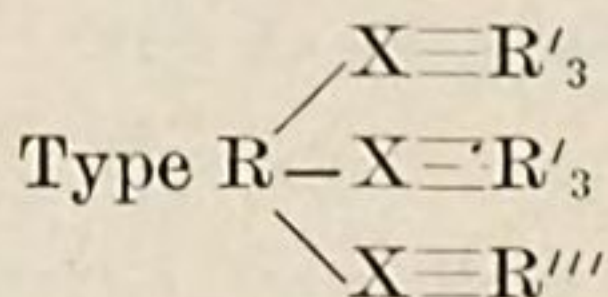
Offretite	$\left[\begin{array}{l} 2\text{Al}_3(\text{Si}_3\text{O}_8)_3\text{K}_2\text{H}.8\text{H}_2\text{O} \\ 1\text{Al}_3(\text{SiO}_4)_3\text{CaH}.8\text{H}_2\text{O} \end{array} \right]$
Gmelinite	} $\text{Al}_3(\text{SiO}_4)(\text{Si}_3\text{O}_8)_2\text{Na}_3.9\text{H}_2\text{O}$
Soda chabazite	



Anorthite	$\text{Al}_6(\text{SiO}_4)_6\text{Ca}_3$
Meionite	$\text{Al}_6(\text{SiO}_4)_6\text{Ca}_2.(\text{CaO}\text{Ca})$
Thomsonite	$\text{Al}_6(\text{SiO}_4)_6\text{Ca}_3.7\text{H}_2\text{O}$
Gismondite	$\text{Al}_6(\text{SiO}_4)_6\text{Ca}_3.12\text{H}_2\text{O}$
Phillipsite	$\text{Al}_6(\text{SiO}_4)_3(\text{Si}_3\text{O}_8)_3\text{Ca}_2\text{K}_2.14\text{H}_2\text{O}$
Levynite	$\text{Al}_6\text{X}_6\text{Ca}_3.15\text{H}_2\text{O}$
Heulandite	} $\text{Al}_6(\text{Si}_3\text{O}_8)_6\text{Ca}_3.16\text{H}_2\text{O}$
Epistilbite	
Stilbite	$\text{Al}_6(\text{Si}_3\text{O}_8)_6\text{Ca}_3.18\text{H}_2\text{O}$
Chabazite	$\text{Al}_6(\text{SiO}_4)_3(\text{Si}_3\text{O}_8)_3\text{Ca}_3.18\text{H}_2\text{O}$

Also the barium feldspars, and the barium-strontium zeolites harmotome and brewsterite. X represents the tetrad groups SiO_4 and Si_3O_8 indiscriminately.

C. Second substitution series.



Natrolite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_2\text{H}_4$
Dumortierite	$\text{Al}_2(\text{SiO}_4)_3(\text{AlO})_6$
Zunyite	$\text{Al}_2(\text{SiO}_4)_3\text{R}'_6$
Chloropal	$\text{Fe}_2(\text{SiO}_4)_3\text{H}_6$
Cancrinite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4\text{H}(\text{AlCO}_3)$
Microsommite	$\text{Al}_2(\text{SiO}_4)_3\text{CaR}'_4$
Prehnite	$\text{Al}_2(\text{SiO}_4)_3\text{Ca}_2\text{H}_2$
Arctolite	$\text{Al}_2(\text{SiO}_4)_3\text{CaMgH}_2$
Biotite	$\text{Al}_2(\text{SiO}_4)_3\text{Mg}_2\text{KH}$
Siderophyllite	$\text{Al}_2(\text{SiO}_4)_3\text{Fe}_2\text{KH}$
Biotite-vermiculite	$\text{Al}_2(\text{SiO}_4)_3\text{Mg}_2\text{H}_2.3\text{H}_2\text{O}$
Biotite-chlorite	$\text{Al}_2(\text{SiO}_4)_3(\text{MgOH})_4\text{H}_2$
Scolecite	$\text{Al}_2(\text{SiO}_4)_3\text{CaH}_4.\text{H}_2\text{O}$
Sodalite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4(\text{AlCl})$

Häüynite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_2\text{Ca}(\text{AlSO}_4\text{Na})$
Nosite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4(\text{AlSO}_4\text{Na})$
Lazurite	$\text{Al}_2(\text{SiO}_4)_3\text{Na}_4(\text{AlS}_3\text{Na})$
Garnet group	$\text{R}'''_2(\text{SiO}_4)_3\text{R}''_3$
Epidote group	$\text{R}'''_2(\text{SiO}_4)_3\text{R}''_2(\text{R}''' \text{OH})$
Leucite	$\text{Al}_2(\text{SiO}_4)(\text{Si}_3\text{O}_8)_2\text{K}_4(\text{AlSiO}_4\text{Al})$
Analcite	Similar to leucite.
Pollucite	Similar to leucite.
Marialite	$\text{Al}_2(\text{Si}_3\text{O}_8)_3\text{Na}_4(\text{AlCl})$

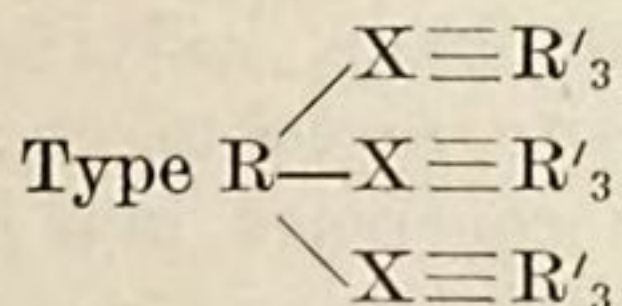
Double type, $\text{R}'''_4\text{X}_6\text{R}''_6$.

Mesolite	$\text{Al}_4(\text{SiO}_4)_6\text{CaNa}_2\text{H}_8.\text{H}_2\text{O}$
Foresite	$\text{Al}_4(\text{SiO}_4)_6\text{CaH}_{10}.\text{H}_2\text{O}$

Conjugate type, $\text{R}'''_2\text{X}_5\text{R}''_7$.

Vesuvianite	$\text{Al}_2(\text{SiO}_4)_5\text{R}''_6(\text{AlOH})$
Gehlenite	$\text{Al}_2(\text{SiO}_4)_5\text{R}''_6(\text{AlO}_2\text{Mg})_2$
Melilite	$\text{Al}_2(\text{SiO}_4)_4(\text{SiO}_3)\text{R}''$

D. Third substitution series.



Phlogopite	$\text{Al}(\text{SiO}_4)_3\text{Mg}_3\text{KH}_2$
Phlogopite-vermiculite	$\text{Al}(\text{SiO}_4)_3\text{Mg}_3\text{H}_3.3\text{H}_2\text{O}$
Phlogopite-chlorite	$\text{Al}(\text{SiO}_4)_3(\text{MgOH})_6\text{H}_3$
Manganophyll	$(\text{AlFe})(\text{SiO}_4)_3(\text{MnMg})_3\text{KH}_2$
Ganophyllite	$\text{AlX}_3\text{Mn}_3\text{R}'_3.2\text{H}_2\text{O}$
Stilpnomelane	$\text{Al}(\text{Si}_3\text{O}_8)_3(\text{FeOH})_6\text{H}_3$
Faujasite	$\text{Al}(\text{Si}_3\text{O}_8)_3\text{R}'_5\text{R}''_2.15\text{H}_2\text{O}$
Cerite	$\text{Ce}(\text{SiO}_4)_3(\text{CeO})_3\text{H}_6$

Double type, $\text{R}'''_2\text{X}_6\text{R}'_{18}$.

Staurolite	$\text{Al}_2(\text{SiO}_4)_6\text{Fe}''_3(\text{AlO})_{12}$
Harstigitite	$\text{Al}_2(\text{SiO}_4)_6\text{Ca}_5\text{Mn}_2\text{H}_4$

E. Basic salts.

Westanite	$\text{AlOH}(\text{SiO}_4)_2\text{Al}_2$
Kaolin	$\text{AlOH}(\text{SiO}_4)_2\text{AlH}_3$
Montmorillonite	$\text{AlOH}(\text{SiO}_4)_2\text{H}_6$
Newtonite	$\text{Al}(\text{OH})_2(\text{SiO}_4)\text{H}_3$
Margarite	$\text{AlOH}(\text{SiO}_4)_2\text{CaH}(\text{AlO})_3$
Strigovite	$\text{AlOH}(\text{SiO}_4)_2\text{AlH}(\text{FeOH})_2$
Aphrosiderite	$\text{AlOH}(\text{SiO}_4)_2\text{Al}(\text{FeOH})_3$
Lepidolite type	$\text{AlF}_2(\text{Si}_3\text{O}_8)\text{R}'_3$
Cookeite type	$\text{Al}(\text{OH})_2(\text{SiO}_4)\text{R}'_3$
Clintonite type	$\text{AlO}_2\text{Mg}(\text{SiO}_4)\text{R}'_3$
Clintonite-vermiculite	$\text{AlO}_2\text{Mg}(\text{SiO}_4)\text{R}'_3.3\text{H}_2\text{O}$
Chloritoid	$\text{AlO}_2\text{Fe}(\text{SiO}_4)\text{H}(\text{AlOH})$
Ottrelite	$\text{AlO}_2\text{Fe}(\text{Si}_3\text{O}_8)\text{H}(\text{AlOH})$

With many members of the chlorite group, such as prochlorite, leuchtenbergite, etc.

F. Borosilicates, etc.

Tourmaline, A.....	$\text{Al}_8(\text{SiO}_4)_6(\text{BO}_3)(\text{BO}_2)_2\text{R}'_5$
Tourmaline, B.....	$\text{Al}_7(\text{SiO}_4)_6(\text{BO}_3)(\text{BO}_2)_2\text{Mg}_2\text{R}'_4$
Tourmaline, C.....	$\text{Al}_6(\text{SiO}_4)_6(\text{BO}_3)(\text{BO}_2)_2\text{Mg}_3\text{R}'_5$
Tourmaline, D.....	$\text{Al}_5(\text{SiO}_4)_6(\text{BO}_3)(\text{BO}_2)_2\text{Mg}_4\text{R}'_6$
Axinite.....	$\text{Al}(\text{SiO}_4)(\text{Si}_3\text{O}_8)(\text{BO}_3)\text{Ca}_3(\text{AlOH})$

And the species cappelinite, karyocerite, melanocerite, and tritomite.

G. Complex silicates.

Spodumene.....	$\text{Al}_6(\text{Si}_3\text{O}_8)_3(\text{SiO}_4)_3\text{Li}_6$
Jadeite.....	$\text{Al}_6(\text{Si}_3\text{O}_8)_3(\text{SiO}_4)_3\text{Na}_6$
Acmite.....	$\text{Fe}_6(\text{Si}_3\text{O}_8)_3(\text{SiO}_4)_3\text{Na}_6$
And in babingtonite the molecule.....	$\text{Fe}'''_6(\text{Si}_3\text{O}_8)_3(\text{SiO}_4)_3\text{Fe}''_3$

To this group of triad silicates, the largest and most important group of all, other species belong which I have not clearly interpreted. Such species are halloysite, allophane, collyrite, schrötterite, sapphirin, ardennite, carpholite, cenosite, sarcolite, etc. The formulæ of the tabulated species must all be construed in a general way—that is, with common replacements of aluminum by ferric iron, magnesium by ferrous iron, and so on. In every case details are suppressed, and these are to be found in the text. The same rule applies to the species in the groups which follow:

2. Ortho- and trisilicates of dyad bases.

Forsterite.....	$n.\text{Mg}_2\text{SiO}_4$
Fayalite.....	$n.\text{Fe}_2\text{SiO}_4$
Tephroite.....	$n.\text{Mn}_2\text{SiO}_4$
Willemite.....	$n.\text{Zn}_2\text{SiO}_4$
Phenakite.....	$n.\text{Gl}_2\text{SiO}_4$
Monticellite.....	CaMgSiO_4
Knebelite.....	MnFeSiO_4
Hyalosiderite.....	$\text{Mg}_4\text{Fe}_2(\text{SiO}_4)_3$
Igelströmite.....	$\text{Fe}_4\text{Mn}_2(\text{SiO}_4)_3$
Trimerite.....	$\text{Gl}_3\text{Mn}_2\text{Ca}(\text{SiO}_4)_3$
Chondrodite.....	$\text{Mg}_3(\text{SiO}_4)_2(\text{MgF})_2$
Humite.....	$\text{Mg}_5(\text{SiO}_4)_3(\text{MgF})_2$
Clinohumite.....	$\text{Mg}_7(\text{SiO}_4)_4(\text{MgF})_2$
Helvite.....	} $\text{Gl}_3\text{R}''_2(\text{SiO}_4)_3(\text{R—S—R})$
Danalite.....	
Bertrandite.....	$\text{Gl}_3(\text{SiO}_4)_2\text{H}(\text{GlOH})$
Calamine.....	$\text{Zn}_2(\text{SiO}_4)_2\text{H}_2(\text{ZnOH})_2$
Lievrite.....	$\text{Fe}_2\text{Ca}(\text{SiO}_4)_2(\text{AlOH})$
Datolite.....	$\text{Ca}_2(\text{SiO}_4)_2\text{H}_2(\text{BO})_2$
Homilite.....	$\text{Ca}_2\text{Fe}(\text{SiO}_4)_2(\text{BO})_2$

Euclase	$\text{Gl}_2(\text{SiO}_4)_2\text{H}_2(\text{AlO})_2$
Gadolinite	$\text{Gl}_2\text{Fe}(\text{SiO}_4)_2(\text{YO})_2$
Friedelite	} $\text{R}''_4(\text{SiO}_4)_4\text{H}_7(\text{R}''\text{Cl})$
Pyrosmalite	
Diopase	$n.\text{CuH}_2\text{SiO}_4$
Karyopilite	$\text{Mn}_3(\text{SiO}_4)_3\text{H}_5(\text{MnOH})$
Villarsite	$\text{Mg}_3(\text{SiO}_4)_2\text{H}(\text{MgOH})$
Serpentine	$\text{Mg}_2(\text{SiO}_4)_2\text{H}_3(\text{MgOH})$
Picrosmine	$\text{Mg}_2(\text{SiO}_3)(\text{SiO}_4)\text{H}_2$
Aphrodite	$\text{Mg}_2(\text{SiO}_4)_2\text{H}_4$
Kerolite	$\text{Mg}(\text{SiO}_4)_2\text{H}_5(\text{MgOH})$
Deweylite	$\text{Mg}_2(\text{SiO}_4)_3\text{H}_6(\text{MgOH})_2.2\text{H}_2\text{O}$
Eudidymite	} $\text{HNaGlSi}_3\text{O}_8$
Epididymite	

3. *Ortho- and trisilicates of tetrad bases.*

Zircon	$n.\text{ZrSiO}_4$
Thorite	$n.\text{ThSiO}_4(?)$
Auerbachite	$\text{Zr}_4(\text{SiO}_4)_3(\text{Si}_3\text{O}_8)$
Malacone	$\text{Zr}_3(\text{SiO}_4)_3(\text{OH})\text{H}$
Eudialyte	$\text{ZrX}_3\text{Cl.Ca}_3\text{Na}_3$
Elpidite	$\text{Zr}(\text{Si}_3\text{O}_8)_2(\text{OH})_2\text{Na}_2\text{H}_4$
Catapleiite	$\text{Zr}(\text{Si}_3\text{O}_8)(\text{OH})_3\text{Na}_3$
Wöhlerite	$\text{Zr}(\text{SiO}_4)_4\text{R}''_5\text{Na}_2$
Yttrialite	$\text{Th}(\text{Si}_3\text{O}_8)_4\text{Fe}''_2(\text{YO})_8$
Astrophyllite	$\text{Ti}(\text{SiO}_4)_4\text{Fe}''_4\text{R}'_4$
Johnstrupite	$\text{Ti}(\text{SiO}_4)_4\text{Ca}_4(\text{CeF}_2)\text{Na}_2\text{H}$
Sphene	$\text{Ca}(\text{SiO}_4)(\text{TiO})$

With rosenbuschite, lävenite, and hörtdahlite, allied to wöhlerite; rinkite and mosandrite, allied to johnstrupite; and keilhauite and tscheffkinite, allied to sphene.

4. *The diorthosilicates.*

Barysilite	$\text{Pb}_3(\text{Si}_2\text{O}_7)$
Melanotekite	$\text{Pb}_2(\text{Si}_2\text{O}_7)(\text{Fe}''' \text{O})_2$
Kentrolite	$\text{Pb}_2(\text{Si}_2\text{O}_7)(\text{Mn}''' \text{O})_2$
Ganomalite	$(\text{PbCa})_3(\text{Si}_2\text{O}_7)$
Okenite	$\text{Ca}_3(\text{Si}_2\text{O}_7)_3\text{H}_{12}$
Gyrolite	$\text{Ca}_4(\text{Si}_2\text{O}_7)_3\text{H}_{10}$
Apophyllite	$\text{Ca}_2(\text{Si}_2\text{O}_7)_3\text{H}_{12}(\text{CaOH})_2$
Plombierite	$\text{Ca}_6(\text{Si}_2\text{O}_7)_3\text{H}_6.9\text{H}_2\text{O}$
Inesite	$\text{R}_6(\text{Si}_2\text{O}_7)_3\text{H}_6.2\text{H}_2\text{O}$
Bementite	$\text{Mn}_6(\text{Si}_2\text{O}_7)_3\text{H}_6$
Spadaite	$\text{Mg}_5(\text{Si}_2\text{O}_7)_3\text{H}_8$
Saponite	$(\text{MgOH})_2\text{H}_4(\text{Si}_2\text{O}_7).(?)$
Iolite	$\text{Al}_6(\text{Si}_2\text{O}_7)_5\text{Mg}_4(\text{AlOH})_2$

Barylite	$\text{Al}_4(\text{Si}_2\text{O}_7)_3\text{Ba}_3$
Sphenoclase	$\text{Al}_2(\text{Si}_2\text{O}_7)_3\text{Ca}_6$
Rowlandite	$\text{Fe}''(\text{Si}_2\text{O}_7)_2\text{Y}_2(\text{YF})_2$

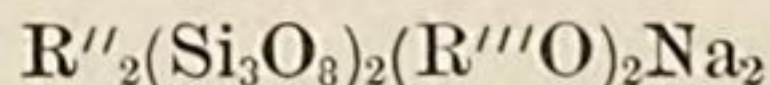
5. *The metasilicates.*

Laubanite	$\text{Al}_2(\text{SiO}_3)_5\text{Ca}_2.6\text{H}_2\text{O}$
Talc*	$\text{Mg}_3(\text{SiO}_3)_4\text{H}_2(?)$
Pyrophyllite	$\text{Al}(\text{SiO}_3)_2\text{H}$
Kyanite	$\text{AlO}(\text{SiO}_3)(\text{AlO})$
Beryl	$\text{Al}_2\text{Gl}_3(\text{SiO}_3)_6$
Leucophanite	$\text{Ca}(\text{SiO}_3)_2\text{Na}(\text{GlF})$
Meliphanite	$\text{Ca}_2(\text{SiO}_3)_2(\text{SiO}_4)\text{GlNa}(\text{GlF})$
Wollastonite	$\text{Ca}_3(\text{SiO}_3)_3$
Pectolite	$\text{Ca}_2(\text{SiO}_3)_3\text{NaH}$
Danburite	$\text{Ca}(\text{SiO}_3)_2(\text{BO})_2$
Chrysocolla	$\text{CuSiO}_3.2\text{H}_2\text{O}(?)$
Neptunite	$\text{Ti}(\text{SiO}_3)_4\text{R}''\text{R}'_2$

Leucite, pollucite, analcite, eudialyte, etc., have been treated as pseudometasilicates. To these species must be added the pyroxenes and the amphiboles, with the following general formulæ:

Pyroxene	$\text{R}''_8(\text{SiO}_4)_2(\text{Si}_3\text{O}_8)_2$
Amphibole	$\text{R}''_4(\text{SiO}_4)(\text{Si}_3\text{O}_8)$

Glaucophane and crocidolite may be written



or all trisilicate, and crossite, waldheimite, etc., seem to be similar. The evidence for these expressions appears in the text.

6. *The dimetasilicates.*

Petalite	$\text{Al}(\text{Si}_2\text{O}_5)_2\text{Li}$
Milarite	$\text{Al}_2(\text{Si}_2\text{O}_5)_6\text{HKCa}_2$
Mordenite }	$\left[\text{Al}_2(\text{Si}_2\text{O}_5)_5\text{CaH}_2.6\text{H}_2\text{O} \right]$
Ptilolite }	
Hyalotekite	$\text{R}''_2(\text{SiO}_5)_3(\text{RF})(\text{RBO}_2)$

* Possibly a pseudometasilicate.

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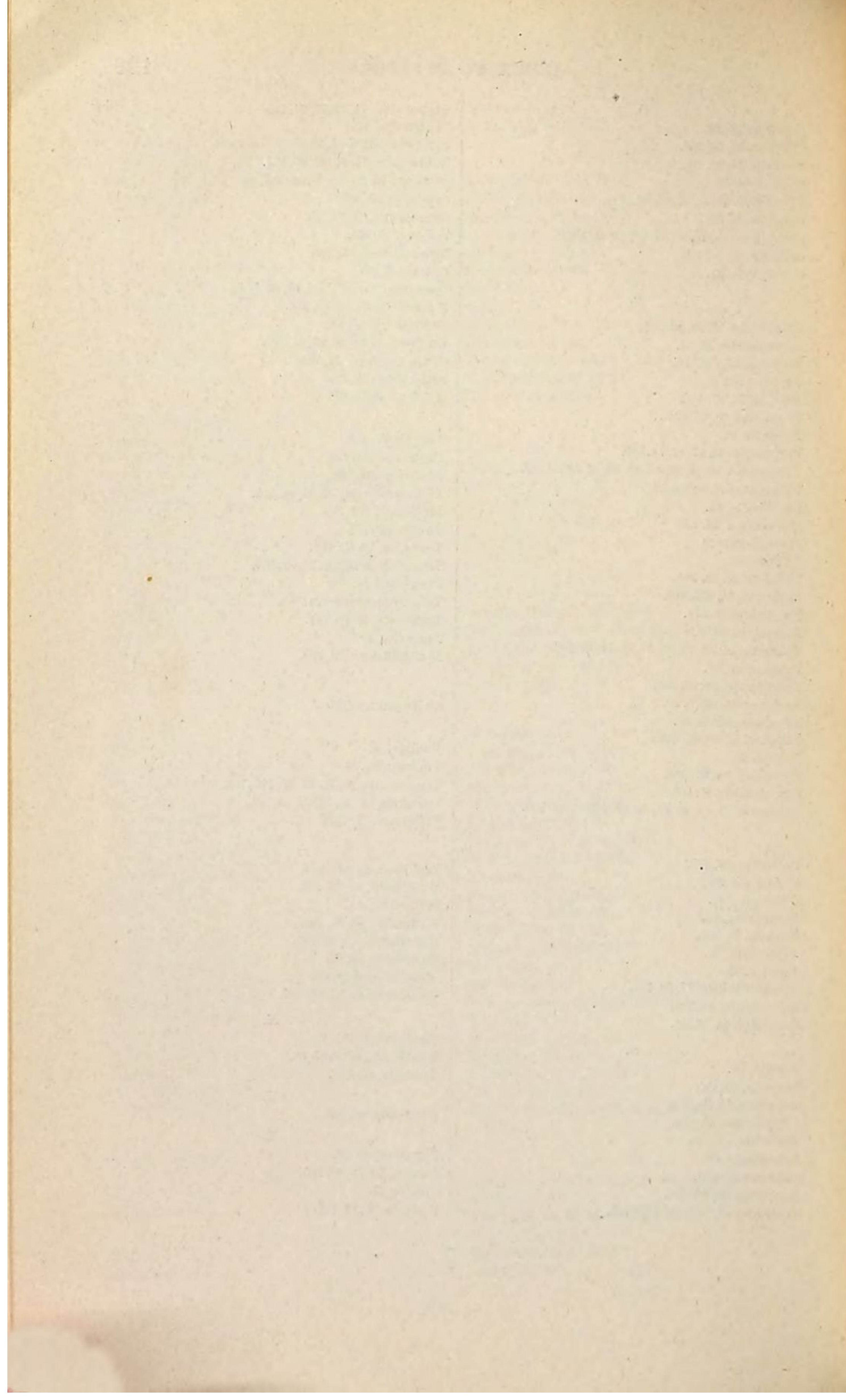
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OF THE

UNITED STATES

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A MINERALOGICAL LEXICON OF FRANKLIN, HAMPSHIRE,
AND HAMPDEN COUNTIES, MASSACHUSETTS.—EMERSON

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TO THE DIRECTOR OF THE

UNITED STATES GEOLOGICAL SURVEY,

WASHINGTON, D. C.

WASHINGTON, D. C., November, 1895.

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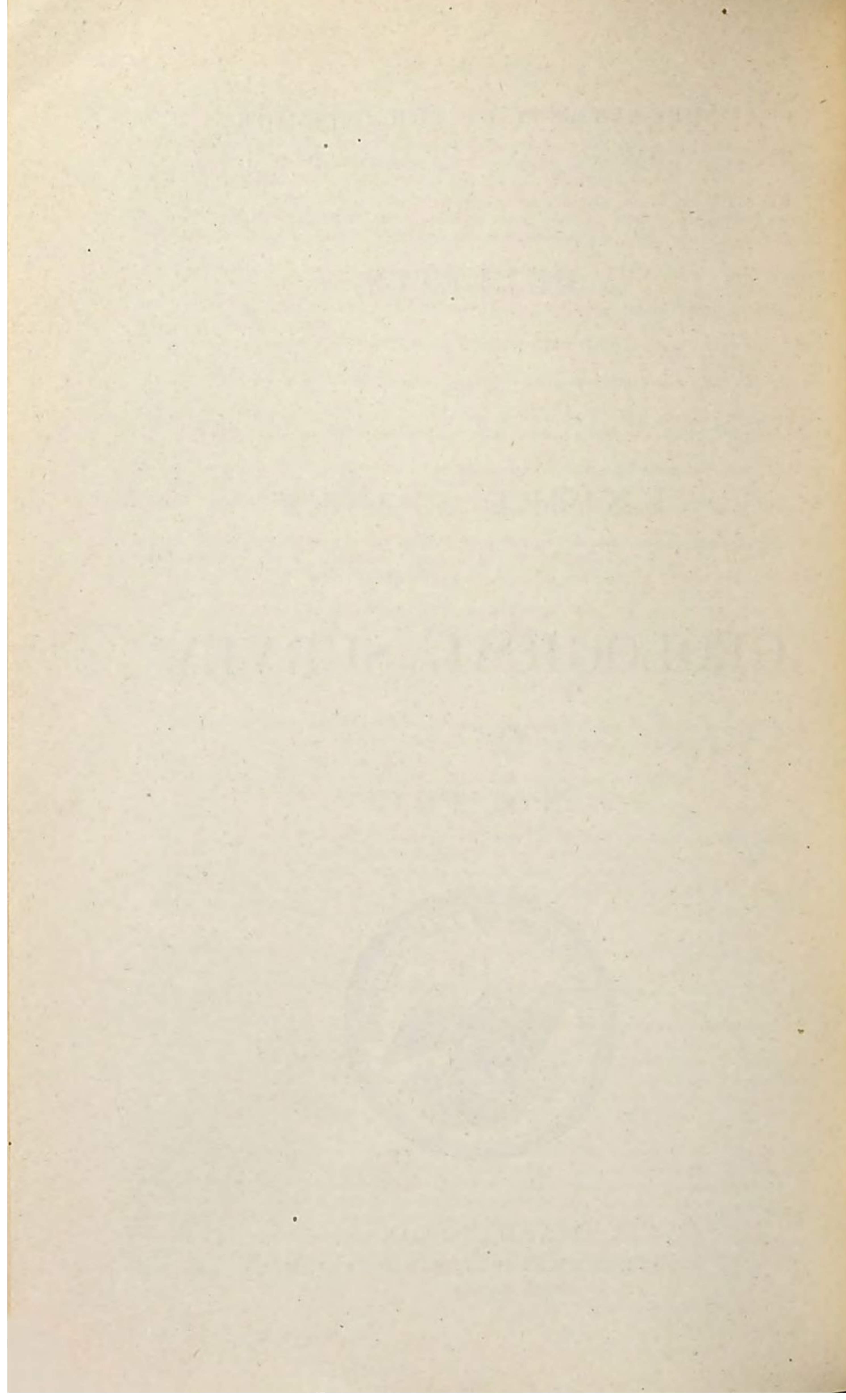
UNITED STATES

GEOLOGICAL SURVEY

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1895



UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

A

MINERALOGICAL LEXICON

OF

FRANKLIN, HAMPSHIRE, AND HAMPDEN COUNTIES
MASSACHUSETTS

BY

BENJAMIN KENDALL EMERSON



WASHINGTON

GOVERNMENT PRINTING OFFICE

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LETTER OF TRANSMITTAL.

AMHERST, MASS., *December 20, 1894.*

SIR: I have the honor to transmit herewith, for publication as a bulletin of the United States Geological Survey, a mineralogical lexicon of Franklin, Hampshire, and Hampden counties, Mass. This lexicon was prepared to accompany a monograph on the geology of this area, but it has seemed desirable to present it for separate publication.

Very respectfully,

BEN. K. EMERSON.

Hon. C. D. WALCOTT,
Director United States Geological Survey.

A MINERALOGICAL LEXICON OF FRANKLIN, HAMPSHIRE, AND HAMPDEN COUNTIES, MASS.

By B. K. EMERSON.

INTRODUCTION.

The purpose of this bulletin is to give a condensed history of each mineral species occurring within the area of the three river counties in Massachusetts. Each citation from the original documents is placed in its proper chronological order under the present name of the mineral to which it refers, and the minerals are arranged alphabetically. In all important cases synonyms, incorrect references, and pseudomorphs are entered in their alphabetical places with cross references to the places where they belong and are fully discussed. When citations are given verbatim, they are inclosed within quotation marks, and when corrections or additions are made to a citation by the author they are inclosed in parentheses. Descriptions, analyses, and remarks unquoted are by the author. In several cases of special interest pseudomorphs, especially those containing several minerals, are entered separately under the names by which they have been described—as hampshirite, cymatolite. Where the mineral was first discovered in this region the author's name is placed in parentheses after the name of the mineral.

The work was prepared as a chapter of a forthcoming monograph upon the geology of the three river counties, but became so large that it seemed best to publish it separately. For this reason many minerals, especially those of lithological interest, are fully discussed in the monograph, and only that portion of their history which is of special mineralogical importance is detailed here.

It has been my purpose to bring out fully the work of the pioneers, and I had added to the monograph a chapter on the history of geological and mineralogical discovery in the valley, which might almost as well have found place here, since the early studies were in the main mineralogical.

Special attention has been given to the genesis, paragenesis, exact locality, and geological position of each occurrence.

In the following table the full column of the geological formations present in the area is given as established in the monograph.

All the minerals are referred to their proper place in this column.

PLEISTOCENE.

Synonyms.

Terrace gravels, sands, and clays.
Champlain clays.
Glacial boulder-clays.

Equivalents along the eastern border of the area and in Worcester County.

TRIASSIC.

The Sugar Loaf arkose, or feldspathic sandstone.

The Mount Toby conglomerate.

The Long Meadow brownstone, or fucoidal sandstone.

The Granby tuff, or diabase ash beds.

The Holyoke and Deerfield diabase beds, or the trap.

DEVONIAN.

Bernardston series.

1. Mica-schist and gneiss.
2. Amphibolite.
3. Quartzite, with limestone beds carrying fossils.

SILURIAN.

Clay-slate.	{	<i>Conway schist, with beds of limestone and amphibolite.</i>	{	Brimfield fibrolite schist.
Calceiferous mica-schist.		<i>Goshen schist, with beds of quartzite.</i>		
Spangled slates (Hitchcock).		<i>Hawley schist, with beds of amphibolite and iron ores.</i>		
	{	<i>Savoy schist, with beds of amphibolite.</i>	{	Hardwick gneiss and Paxton quartz schist.
Talcoose slates, or talcoid slates.		<i>Chester amphibolite, with beds of saxonite, serpentine, steatite, emery, and magnetite.</i>		
Hydromica-schists (Dana).		<i>Rowe schist, with amphibolite beds.</i>		
		<i>Hoosac schist (upper part).</i>		

CAMBRIAN.

Hoosac schist (lower part).
Becket gneiss.

} Monson and Pelham gneiss.

PRE-CAMBRIAN.

Washington gneiss.
Lee gneiss.
Hinsdale limestone.

LEXICON.

ACMITE.

1841. **Acmite.** Chester. See Tourmaline.

E. Hitchcock: Geol. Mass., 1841, p. 614.

ACTINOLITE.

See Amphibole.

AGLAITE.

1877. **Aglaite.** (Julien.) Chesterfield.

A. A. Julien: Synonym of cymatolite; a pseudomorph after spodumene.

See ALBITE, 1877. (Name never used.)

ALBITE.

1817. **Kieselspath.** Chesterfield.

G. F. L. Hausmann: Göttinger Gelehrte Anzeigen, p. 1401.

1819. **Siliceous feldspar.** Chesterfield, Goshen.

"When I first examined this rock, soon after its discovery by Dr. Hunt in Northampton, I determined the feldspar to be a new variety, which has since been confirmed by Professor Hausmann, and now ranks as a new subspecies, under the name of siliceous feldspar." A full and accurate description of the mineral follows:

An analysis of Stromeyer is given:

SiO ₂	.....	70.68
Al ₂ O ₃	.....	19.80
NaO	.....	9.06
CaO	}	.38
FeO		
MgO		
		99.91

On the Tourmalines, etc.; G. Gibbs: Am. Jour. Sci., 1st series, Vol. I, p. 346.

1820. **Siliceous spar.**

"Soon after Dr. Hunt discovered this mineral, Colonel Gibbs pronounced it a new one."

A. Eaton: Index, p. 121.

1821. **Kieselspath.** Chesterfield.

Analyzed at request of Hausmann:

SiO ₂	70.68
Al ₂ O ₃	19.80
NaO	9.06
CaO	.23
FeO (MnO)	.11
	99.88

The analysis cited above by Gibbs is also given.

M. Stromeyer: *Chemische Untersuchungen*, Göttingen, p. 307.

1823. **Siliceous feldspar.** (Gibbs.) Chesterfield.

"Also at Goshen—a new variety discovered by Dr. Hunt."

E. Hitchcock: *Geol. Connecticut River*, Am. Jour. Sci., 1st series, Vol. VI, p. 221.

1823. **Cleavelandite.** (H. J. Brooke.) Chesterfield.

Brooke: *Annals Philos.*, Part II, Vol. V, p. 381.

1824. **Kieselspath.** Chesterfield.

Stromeyer's analysis quoted. "It is plain that this mineral is a species of feldspar with a base of soda."

Editor's note: Am. Jour. Sci., 1st series, Vol. VII, p. 370.

1824. **Siliceous feldspar.** Chester, Chesterfield.

"Bluish white, laminae often curved, and sometimes of a stellular form. Abundant at Chester (Emmons). It is probably in the same bed as that at Chesterfield."

C. Dewey: *Geol. and Min. of part of Massachusetts*; Am. Jour. Sci., 1st series, Vol. VIII, p. 43.

1824. **Albite.** Chesterfield, Chester.

"The siliceous feldspar of Chesterfield passes into a granular variety almost exactly resembling the albite of Sweden. In Chester it is fine and coarse granular."

C. Dewey: *Loc. cit.*, p. 43.

1835. **Feldspar (Albite?).** Middlefield.

"In loose masses lining small cavities in a rock made up of hornblende, augite, and masses of feldspar."

C. U. Shepard: *Min.* Vol. II, Part I, p. 203.

1836. **Albite.** Chesterfield.

Analysis by Laurent and Holms:

SiO ₂	68.4
Al ₂ O ₃	20.8
Fe ₂ O ₃ {	
Al ₂ O ₃ {	.1
CaO	.2
NaO	10.5
	100.0

Ann. de Chimie, Vol. LX, p. 331; Am. Jour. Sci., 1st series, Vol. XXX, p. 381.

1841. **Albite.** Goshen, Chesterfield, Norwich, New Salem.

Goshen, Chesterfield, foliated and granular; Norwich, foliated and light-blue; New Salem, white foliated; also Chester.

E. Hitchcock: *Geol. Mass.*, p. 703.

1844. **Albite.** (*Spatum trichlinatum.*) Chesterfield. Goshen (cleavelandite).

J. D. Dana: Sys. Min. p. 352.

1882. **Albite.** Greenfield.

In the cavities in the amygdaloid, from the shores of the Connecticut, opposite Turners Falls, which are often only partly filled with the vermiform diabantite, and out of which the latter may be shaken as a deep-green powder, there occur minute crystals loosely seated upon the diabantite, or in the powder shaken out from the cavities and scarcely attached at all. They are 0.005-0.01 mm. in diameter, transparent, perfectly fresh crystals, twinned in accordance with the albite law. They are combinations of the form $\infty P \infty$, ∞P , $\infty \bar{P} 3$, $\infty \bar{P} \bar{3}$, $\infty P'$, $\infty P'$, $\infty \bar{P} \infty$, $2 \bar{P} \infty$, flattened by the large development of $\infty \bar{P} \infty$ and much elongated in the direction of the axis $\bar{a}$, by one end of which they are uniformly attached. Examined with the polarizing microscope the line of extinction on the face $0 P$ makes with the edge $0 P \wedge \infty \bar{P} \infty$ an angle of $+4^\circ$ to $+4^\circ 30'$. When lying upon the face $\infty \bar{P} \infty$ the minute twins gave varying results.

When placed in a delicately graduated Thoulet's fluid, so prepared that orthoclase will rest near the surface and labradorite near the bottom, the crystals found the exact level of fragments of transparent albite from Haddam, sp. gr. 2.62, and remained attached to them as if they were so delicately freed from outward attraction that they gravitated toward one another. Some of the crystals having diabantite adherent to them sank to the level of quartz, sp. gr. 2.64, but all were separated by a broad interval from the other triclinic feldspars. The position of these crystals is interesting from a paragenetic point of view. The cavities are tapestried on all sides by the diabantite and the albite crystals rest upon it, often very loosely, and while forming they projected freely into the interior, as is shown by their glassy clearness and perfection of form and polish. The last of the diabantite seems sometimes to fill the cavities into which the albites project, but this could not be ascertained with certainty. As the albite probably demands elevated temperature and increased pressure for its formation, the diabantite upon which it rests must be assigned to the time following immediately the consolidation of the lava, while its heat still intensified the chemical activity of the water it contained.

B. K. Emerson: The Deerfield dyke and its Minerals; Am. Jour. Sci., 3d series, Vol. XXXIV, p. 201.

1882. **Cleavelandite.** Chesterfield, Goshen, Northfield.

Still occurs in greatest abundance and beauty at Clarks Ledge, in Chesterfield; also at the spodumene locality at West Chesterfield Hollow, and at the colored tourmaline locality at the Barras farm, in Goshen, and at a new locality on the top of Strowbridge Hill, in Northfield. This is a mile south of the spodumene locality in the farmyard of Mr. M. A. Browne, in the southwest corner of Winchester, N. H., and is apparently in the prolongation of the same pegmatite dike.

1885. **Cleavelandite.** Huntington.

In blasting for spodumene fine specimens were obtained on Norwich Hill, though not abundantly, with the spodumene, but I found no colored tourmalines with it, although the black tourmaline occurs in large masses.

1885. **Albite.** South Hadley.

From diabase on road north from Moodys Corners, South Hadley. Crystals, 4 mm. long, 2 mm. wide, 2 mm. thick, $0, \infty P \infty, \infty P'$, twinned parallel to $\infty P \infty$ and elongate parallel to $\bar{a}$; slice cut parallel to $\infty P \infty$ (M) gave extinction $+20^\circ$.

1886. Albite. Northampton.

In veins in the granite at a quarry south of W. N. Moore's east of Florence, as hollow incrustations—pseudomorphs after laumontite. The hollow forms show on both outside and inside fine drusy surfaces of fresh, limpid, much-twinned crystals. Extinction on $M\ 18^{\circ}\ 45' - 19^{\circ}$. (This pseudomorph has been cited only from Scotland by J. R. Blum: *Dritter, Nacht. zu den Pseudomorphosen*, 1863, Erlangen, p. 67.)

1891. Periklin.

Appears (1) in fine large crystals in cavities in the sericite schists at various places in Chester; (2) in hornblende-schist, adjoining granite, east of the soapstone quarry in North Blandford; (3) in fissures in crushed argillite, in Whately; (4) in crystals over an inch long, opaque white, with polished surfaces, closely resembling the forms from the Tyrol, at Ice Rock, a mile below the village of Shelburne Falls, on the river.

For albite-muscovite pseudomorphs after spodumene, see Cymatolite.

ALLANITE.

1841. Rutile. Northampton and Williamsburg.

"Associated with quartz in the sienite is a mineral crystallizing in four-sided prisms, which I have been disposed to refer to rutile." (The sienite is the same as the tonalite mentioned below.)

E. Hitchcock: *Geol. Mass.*, p. 677.

1876. Allanite. Pelham, Ware, Becket.

C. U. Shepard: *Catalogue of Minerals within 75 miles of Amherst*, p. 7.

1876. Allanite. Hatfield, Pelham, Gilbertville, Buckland.

It is a constant accessory constituent of the Hatfield tonalite and is quite abundant in the granular anorthite at the Pelham asbestos quarry. The crystals are here one-twelfth to one-half inch across, and 1 to 2 inches long. Some crystals are bordered by a dark-brown layer 1 mm. thick and cleaving parallel to a plane rectangular to the prism, which latter shows a varnished surface when the outer layer is removed. A marked puckering of the feldspar surrounds the prisms of allanite.

Certain crystals are deep bottle-green in longitudinal section, black in transverse. Under the microscope the Pelham allanite in cross-section about at right angles to c is clear and free from fissures. It shows a clear dichroism in two shades of red-brown and undulose polarization in stellate bands of shade radiating from several points. It shows no border growth except a fringe of sagenitic rutile, and no decomposition.

It occurs also in the Pelham gneiss (in which the peculiar anorthite-olivine lens, generally cited as the asbestos quarry, is included) at the agricultural college quarry, in the north part of the town. It appears here in the small pebble-like "augen" of orthoclase, which are strung along certain lamination planes in small square prisms, changed generally into a red-brown hydrated variety. A radiated puckering of the feldspar surrounds each crystal. The finest crystals occur at Gilbertville, near Ware, in coarse granite—flattened prisms 2 inches long and a half inch wide, with corroded and varnished surfaces.

In Buckland, on the hilltop a few rods south of Harris's soapstone quarry; as usual, superficially decomposed to a red substance.

1894. **Allanite.** Pelham.

The well-known asbestos mine in Pelham, Mass., is opened on a great dike of black olivine-enstatite rock inclosed in gneiss. The metamorphism which changed the Cambrian conglomerate into gneiss changed the olivine rock, along a network of fissures, into anthophyllite, arranged in transverse fibers, meeting in a suture—a macroscopic olivine network.

A macroscopic “reaction rim” was produced between the two rocks by the interaction of the very basic and the very acid members. Against the olivine rock is a broad band, characterized by very basic minerals—thick bands of biotite, containing apatite, and fine large corundum crystals. Then comes anorthite full of allanite, rutile, and tourmaline in large masses. Then the anorthite graduates into andesite, and this, by the gradual appearance of quartz, microcline, and biotite, into the common, well-bedded gneiss.

A crystal of corundum was shown—largely fine-blue sapphire, in which was a crystal of allanite a half inch across, which had coerced the corundum into a fine radiated puckering nearly an inch wide, outside of which the fine cleavage of the corundum asserted itself. The same puckering surrounds the allanite in the massive anorthite.

B. K. Emerson: Bull. Geol. Soc. Am., VI, p. 474.

ALLOPHANE.

1868. **Allophane.** Greenfield.

White and greenish; in sandstone quarry one-half mile east of village of Greenfield.

J. D. Dana: Min. Localities, Treatise, p. 769.

1880. **Allophane.** Belchertown.

In greenish coating on pink feldspar veins; in hornblende-schist at Kelleys Crossing, in Belchertown.

AMESITE.

1876. **Amesine** (nov. sp.?). (Shepard.) Chester emery mine.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst, p. 4.

(Named after Mr. James T. Ames, of Chicopee, part owner of the emery mine.)

1876. **Amesite.** Chester.

“M. Shepard a donné ce nom à un minéral qui se trouve sur du diaspore à Chester et qui ressemble comme couleur et comme éclat au talc vert du Tyrol, ou bien à certaines chlorites du Piémont; il rappelle aussi l'aspect de la pyrosclérite de l'île d'Elbe, quoique sa couleur soit plus pâle (Desc.).

H. 2.5–3.0 gr. 2.71, op. ax. positive.

“SiO₂ 21.40

“Al₂O₃ 32.30

“FeO 15.80

“MgO 19.90

“H₂O 10.90

“C'est donc une espèce distincte.”

M. F. Pisani: Notices Minéralogiques; Compte Rendu, Vol. LXXXIII, p. 166.

1882. Amesite.

"Apparently identical with corundophyllite."

E. S. Dana: 3d Appendix to 5th ed. Dana's Min., p. 31.

(Professor Shepard has never published any description of the mineral.)

1885. Amesite.

The corundophyllite, which is the oldest mineral in the veins where it occurs, forming on each wall a selvage against the magnetite, changes in specimens I have recently obtained into the pale whitish-green amesite; so that there can be no doubt of the derivation of the one from the other. The typical specimens of amesite labeled by Professor Shepard are in crystals of the same size and proportion as the corundophyllite, and occupy the same position in the fissures, coating the magnetite on either side and having a layer of diaspore between them. They agree with the corundophyllite in being optically positive, but with small angle. The axial angle varies from 20° to 28° in a single crystal of amesite and from 32° to 70° in one of corundophyllite. The crystals of amesite are often made up of three individuals, and in cleavage plates the axial planes of the three parts make angles of 60° with each other.

1891. Amesite. Chester.

In an elaborate article upon the chlorites Tschermak has taken amesite as the first member of a series which includes all the principal chlorites, and these are formed from it by adding an increasing number of serpentine atoms to the amesite atom, which is the richest in alumina. Thus corundophyllite is composed of one molecule of serpentine and four of amesite. This is abstracted fully in E. S. Dana's Manual of Min., p. 643.

G. Tschermak: Die Chloritgruppe. Sitzungsberichte d. Akad. Wien, XCIX, p. 212.

(The above would suggest that the amesite may have been derived from the corundophyllite by its splitting into four molecules of amesite and one of serpentine. I have found no serpentine which would seem to have had this origin associated with the amesite.)

AMPHIBOLE.**1818. Hornblende. Deerfield.**

"Very abundant; mostly black in this vicinity."

E. Hitchcock: Geol. Deerfield, etc.; Am. Jour. Sci., 1st series, Vol. I, p. 113.

1820. Actynolite. Middlefield.

Often containing small tufts of the fibrous variety. Discovered by E. Emmons.

Professor Dewey: Am. Jour. Sci., 1st series, Vol. II, p. 236.

1822. Actynolite. Middlefield (Mr. Coleman). Cummington (Dr. J. Porter).

As beautiful as that of the Tyrolese Alps.

Editor's note, *ibid.*, Vol. IV, p. 54.

1823. Hornblende.

Lamellar hornblende occurs in Holland (Eaton), Leverett, Sunderland, Conway, etc. Black hornblende in Shutesbury, green in sienitic granite and gneiss; at Leyden, in fine fibers; also in Shelburne, Conway, Goshen, etc., in mica-slate, in large or broad fibers (latter citation = zoisite).

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 226.

1823. **Fasciculite.** (Hitchcock.) Hawley, Plainfield, Conway.

This is composed of fibers, or rather in many instances of lamellæ, frequently more than one-tenth of an inch broad, diverging at both ends so as to occupy usually as many as 60° of a circle. These lamellæ are commonly inserted perpendicularly to the folia of the slate in which they are inserted, and are applied to each other by their broader faces being bent outward on both sides somewhat like a bow, and presenting elegant and very perfect fascicles. The fibers or lamellæ scarcely, if ever, cross one another, yet sometimes they diverge in nearly straight lines and sometimes are so much curved as to resemble very exactly a sheaf of wheat. Length, 1 to 4 inches. In mica-slate and talco-micaceous slate in Hawley, Plainfield, and Conway. I could not resist the temptation to denominate them fasciculites.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 226.

1823. **Hornblende, Actynolite.** Hawley (Eaton), Cummington (J. Porter), Belchertown, Shutesbury in gneiss, New Salem, acicular crystals in chlorite.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 227.

1823. **Tremolite.** Chesterfield, Cummington.

Asbestos with actynolite at Windsor, near the Cummington soapstone quarry.

J. Porter: Min. Loc.; Am. Jour. Sci., 1st series, Vol. VI, p. 248.

(This is called scapolite (ibid., Vol. VII, p. 253), but is probably zoisite.)

Cummington; radiated, with quartz and beautiful garnets.

1823. **Hornblende.** Hawley. Plainfield, etc.

Describes the fasciculite of Hitchcock.

Ibid.

1824. **Tremolite.** Middlefield.

In large masses of aggregated flattened crystals with rhomb spar (Emmons). These crystals often pass off into a perfectly granular tremolite.

C. Dewey: Geol. Berkshire; Am. Jour. Sci., 1st series, Vol. VIII, p. 46; Robinson's Cat., p. 60.

1824. **Cummingtonite.** (Dewey.) Cummington.

"I have here given this name to a mineral found by Dr. J. Porter in Cummington. It appears to be a variety of epidote. Its color is gray, sometimes with a faint reddish tinge, unless when acted on by the weather, when its color is yellowish. It is in distinct prisms, with oblique seams like zoisite, and in radiated or fascicled masses, which are composed of slender prisms. Luster somewhat shining or pearly. It is nearly as hard as quartz, and sometimes makes a slight impression upon rock crystal. Before the blowpipe it blackens, and a small portion melts, when the heat is very great, into a black slag, which is attracted by the magnet. With quartz and garnet it forms a large mass in Cummington."

C. Dewey: Geol. Min. Mass.; Am. Jour. Sci., 1st series, Vol. VIII, p. 59.

1824. **Cummingtonite.** Lies by the roadside in the east part of Cummington.

Known to the common people for several years under the name of copperas rock, occasionally used in dyeing as a substitute for sulphate of iron.

J. Porter: Min. Loc.; Am. Jour. Sci., 1st series, Vol. VIII, p. 233.

1824. **Hornblende.** Pelham.

Also actynolite in asbestos, Pelham, and likewise a granular variety of the same mineral in large masses—the grains equaling in size the grains of coarse gunpowder, and very easily separable. Its granular structure may be the result of semidisintegration.

C. W. Shepard: Min. Loc.; Am. Jour. Sci., 1st series, Vol. VIII, p. 235. Should be C. U. Shepard.

1825. **Fasciculite.** Charlemont (Dr. H. W. Wells).

Very fine.

J. Porter: Min. Loc.; Am. Jour. Sci., 1st series, Vol. IX, p. 54. Robinson's Cat., p. 40.

1825. **Cumingtonite.** Plainfield in considerable quantities.

It is perfectly well characterized, many of the specimens being elegant and even superb.

J. Porter: Min. Loc.; Am. Jour. Sci., 1st series, Vol. IX, p. 54.

1825. **Asbestos.** Zoar.

The ligniform variety abundant in serpentine on the banks of Deerfield River (H. M. Wells).

Robinson's Cat., p. 78.

1825. **Actynolite.** Westfield, occasionally; fine.

Emerson Davis: Min. Not.; Am. Jour. Sci., 1st series, Vol. IX, p. 252.

1825. **Cumingtonite (Fibrolite).** Cumington.

E. Emmons: Boston Jour. Phil. and Arts, Vol. III, p. 395.

1825. **Fibrolite.** Chesterfield.

E. Hitchcock, *ibid.*, p. 610.

1825. **Anthophyllite.** Zoar (Charlemont).

In serpentine resembles that found in Blandford.

C. U. Shepard: Boston Jour. Phil. and Arts, Vol. III, p. 309.

1825. **Anthophyllite.** Blandford.

"Mr. Alonzo Chapin has lately presented me with a mineral that he has discovered in considerable abundance in the town of Blandford, which I find to be very well characterized anthophyllite. In a green talcose rock having a slaty structure, with veins of blackish serpentine running through it; massive and in long acicular prisms, radiating, hair brown." Cleavage, 125° . Infusible.

C. U. Shepard: Min. Loc.; Am. Jour. Sci., 1st series, Vol. IX; also Boston Jour. Phil. and Arts, Vol. II, p. 395.

1827. **Cumingtonite.** Chesterfield, Goshen.

In mica-slate.

A. Nash: Lead Mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 260.

1827. **Amianthus.** Plainfield.

White, very fine and delicate.

J. Porter: Min. Loc.; *ibid.*, p. 378.

1828. **Anthophyllite.** Blandford, 20 rods southeast of village; East Granville road; also 1 mile south on same road.

Hitchcock searched out the mineral at the above locality as the anthophyllite described by Shepard in the preceding citation. It fused, and so he sent specimens to Professor Shepard to see if they were the same as his. Professor Shepard writes that the mineral sent agrees in crystallographical characters and in its fusibility with a genuine specimen of anthophyllite from Norway, and says: "This led me to reexamine a mineral from

1828. **Anthophyllite**—Continued.

the same town which I recently described in the Boston Journal under the name of anthophyllite. I find myself to have been in error as to my examination of its crystalline form and some other characters. At present I regard this mineral as constituting a new species, of which I propose at a future day to give a particular account."

E. Hitchcock: Min. Ex.; Am. Jour. Sci., 1st series, Vol. XIV, p. 221.

(The mineral described above by Hitchcock is the coarse-bladed hornblende in the Osborne soapstone quarry, which is partly brown and associated with black serpentine. That first described by Professor Shepard, if infusible, may have been enstatite from farther south. The promised description of it as a new species apparently never appeared.)

1828. **Actynolite**. Center of Shutesbury opposite mineral spring.

E. Hitchcock: Min. Ex.; *ibid.*, Vol. XIV, p. 217.

1828. **Anthophyllite**. Chesterfield, 1 mile north of meetinghouse on land of Mr. Searle, with kyanite and zoisite.

E. Hitchcock: Min. Not.; *ibid.*, p. 216. (This is the brown fibrous hornblende associated with large garnets and called above cummingtonite.)

1835. **Anthophyllite**. Chesterfield, Blandford.

With quartz in mica-slate.

C. U. Shepard: Min., Vol. II, Part I, p. 27.

(The Chesterfield mineral was cummingtonite. The Blandford mineral was actynolite, cited in 1833, probably from Osborne soapstone quarry.)

1835. **Tremolite** in rhombspar. Middlefield; also ligniform and compact asbestos.

E. Hitchcock: Geol. Mass., p. 363.

1835. **Actynolite**. Middlefield, Blandford, Zoar.

E. Hitchcock: Loc. cit.

1835. **Fasciculite** in talcose slate. Plainfield.

E. Hitchcock: Loc. cit.

1835. **Anthophyllite**. Pelham, in gneiss.

E. Hitchcock: Geol. Mass., p. 399.

I can not feel sure what mineral was intended here; probably the black hornblende, which occurs rarely in the gneiss.

1835. **Anthophyllite**. Chesterfield, with sappare (cyanite) and garnet; Chester, with pyroxene, garnet, and staurotide; Blandford, abundant.

In fibrous masses or imperfect prisms embedded in the mica-slate.

E. Hitchcock: Geol. Mass., p. 347; also, Final Report, 1841, p. 606.

1835. **Cummingtonite** (= epidote. Dewey.) Cummington and neighboring towns. Warwick.

E. Hitchcock. *Ibid.*

1835. **Cummingtonite**. Plainfield. Cummington.

Hemiprismatic wavelline spar. Full description and analysis by Muir. Columnar, ash-gray; H 6.5, gr. 3.2014:

SiO ₂	56.543
FeO	21.669
Mn	7.802
Na ₂	8.439
H ₂ O	3.178

C. U. Shepard: Min., Vol. II, Part I, p. 159.

1841. **Cummingtonite.** Cummington. In mica-slate.

"Dr. Thompson is decidedly of opinion that this mineral belongs to a new species allied to the karpfolite."

E. Hitchcock: Geol. Mass., p. 607.

1841. **Actynolite.** Middlefield, Zoar, Blandford.

In talcose slate. Finest from Blandford; in talcose slate, fine fibrous hornblende. Fasciculite.

Ibid., p. 613.

1841. **Hornblende.** Chester.

"Near the chromite-of-iron locality, in the west part of Chester, a mineral occurs in talcose slate in indistinct prisms of a black color, which I shall call hornblende; but I should not be surprised if a more careful examination than I have found time to make should prove it to be acmite, which comes to us from Norway only."

Ibid., p. 614.

(This is the black radiated tourmaline in hexagonal prisms from the North mine and along the whole eastern selvage of the emery vein, which closely resembles hornblende, and was described by Shepard as tourmaline.)

1841. **Tremolite.** Middlefield.

In bitter spar in serpentine. Ligniform and compact varieties are found in the same steatite bed; also at Zoar, in talcose slate.

E. Hitchcock: Geol. Mass., p. 613.

1841. **Actynolite.** Westfield, in serpentine.

"Also a mineral which I am disposed to refer to anthophyllite." (This is enstatite.)

Ibid., p. 618.

1844. **Cummingtonite.** (*Augitus scopiformis*.) Cummington and Plainfield.

J. D. Dana: Sys. Min., p. 373.

1844. **Hornblende.** Chester; with obtuse edges truncated.

F. Alger: Min., p. 83.

1876. **Anthophylline.** Chesterfield, Pelham.

C. U. Shepard: Cat. of Min., within 75 miles of Amherst College, p. 5.

1878. **Cummingtonite.**

Iron magnesia amphibole.

J. D. Dana: Min., p. 234.

1885. **Hornblende.** Chester.

A fibrous black hornblende from near Chester, Mass.; affords an imperfect cat's-eye.

G. F. Kunz: Precious stones; in Min. Res. of U. S., 1885, p. 728.

"Some time ago there were a number of pieces sold in New York as coming from Chester, Mass. It was a fibrous hornblende, in fiber almost as fine as crocidolite. I think someone called it Bentonite."

G. F. Kunz: Private communication, Feb. 5, 1886.

1885. **Actinolite.** North Blandford.

In large quantity; fine, acicular, deep-green, and in all stages of change to steatite, at Bartholomew's quarry, North Blandford, and in still larger and finer masses at Osborne's quarry, near the middle of the same town. In granular masses of the finest emerald-green at the Pelham asbestos mine.

1890. **Cummingtonite.** Chesterfield.

The hair-brown hornblende, so long called anthophyllite, occurs in a highly pyritous rock associated with large garnets, and can be best obtained in the bluffs west of Bunnells Pond, in Chesterfield, and from large boulders down the hill nearly a mile southeast of Chesterfield church.

1891. **Actinolite.** Pelham.

The new excavations have afforded the richest-colored deep-green actinolite, in long, fibrous, sheaf-like, and radiating masses.

1891. **Hornblende** changed to a mixture of epidote and chlorite. Chester.

Very attractive specimens were furnished abundantly from the first cut west of the Chester station, flat black blades penetrating a white granular quartzite forming a bed in the hydro mica-schist. This hornblende is at times altered into a mixture of granular epidote surrounded by a superficial layer of blackish-green chlorite. (See Epidote.)

1891. **Fasciculite** changed to biotite.

The "fasciculite" or radiating hornblende of the Charlemont "fasciculite schists" is at times changed into a dark-brown to black biotite, arranged in a series of overlapping scales about as broad as the cross-section of the thin blades of the original mineral.

1891. **Crocidolite.** Chester.

A pale-green, rigidly columnar mineral, breaking in rods about 4 inches long, was distributed in exchange by Professor Shepard under this name. It is a granular calcite-asbestos mixture, only a few fibers being left behind in acid. Under the microscope narrow, wavy bands of serpentine are seen to run through the mass.

AMPHODELITE.

See Oligoclase.

ANALCITE.

1818. **Analcime.** Deerfield.

Very abundant, associated with quartz and amethyst, which are sometimes inclosed in analcime; generally cylindrical, reniform, radiated, a few perfect crystals. One mile from Deerfield Academy, E. 2° 15' S.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1818. **Analcime.** Deerfield.

Occurrence in secondary greenstone.

Review of Cleaveland's Mineralogy, by E. Hitchcock; Am. Jour. Sci., 1st series, Vol. I, p. 49.

1823. **Analcime.** Deerfield.

Usually in laminated or radiated masses which are reniform, cylindrical, or nearly spherical; very rarely in trapezoidal crystals; color white, gray, and flesh color. Associated with calcareous spar, quartz, chalcedony, etc., and frequently effervesces a little with acid.

E. Hitchcock: Geol. Conn.; *ibid.*, Vol. VI, p. 224.

1835. **Analcime.**

Occurrence doubtful.

E. Hitchcock: Geol. Mass., small ed., p. 436.

1841. **Analcime.** Chester, in mica slate (Emmons).

E. Hitchcock: Geol. Mass., p. 606.

(It occurred in beautiful amber-colored crystals on fissures in hydro-mica-schist. There were fine specimens in the Shepard collection. I have not been able to recover the locality.)

1841. **Analcime.**

"Has been frequently said to be quite common, but I am suspicious that calcareous spar has been confounded with that mineral, and I dare not say that it exists in our greenstone."

E. Hitchcock: Geol. Mass., p. 662.

1876. **Analcite.** Chester.

C. U. Shepard: Cat. of Min., within 75 miles of Amherst College, p. 4.

1882. **Analcite.** Deerfield.

Occurred (*a*) in a single crystal upon prehnite; (*b*) in flat 8-sided plates, 10 to 12 mm. across, striated and formed by the growth of the trapezohedron in a narrow fissure; (*c*) in milk-white films circular and octagonal, 5 to 10 mm. across; (*d*) in extremely fine botryoidal surfaces with crystalline structure, with here and there a system of curious concentric depressed rings, like the siliceous annulations on some fossils (beckite). They are as if formed by pressing several rings, each smaller than the other, into a soft mass, so that it should rise as a series of thin concentric combs between them; (*e*) other pieces which seem to me to have been analcite of the form (*b*) are now wholly decomposed into a yellow ferruginous kaolin (?).

Associated with the analcite (*b*) and resting against the separate crystals on all sides is opaque white calcite $\frac{1}{4}$ R and 1^b, grouped in parallel clusters, the faces all rounded and the clusters looking as if they had been made of some soft material which had "run." This grouping of the calcite around the separate crystals of the analcite may explain the annulations mentioned above, the two minerals having increased alternately and the calcite afterwards having been removed.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 201

ANDALUSITE.

1885. **Chiastolite.** Whately, Mass.

The Whately argillite is changed on contact with the Hatfield tonalite (sienite) to a "garben schiefer" full of slender chiastolites above an inch long, but altered now to a mixture of muscovite and minute and perfect staurolite crystals. The chiastolite pseudomorphs still retain the black cross of coaly particles.

1890. **Chiastolite.**

For supposed chiastolites in the Trias, see Salt.

1893. **Chiastolite.**

"Crystals from Springfield" cited from Dana. (Sys. Min., 6th ed., 1892, p. 497.)

F. Becke: Tschermak Min. Mit., Vol. XIII, p. 257.

(The crystal is a common Lancaster crystal, which is said by Dana to have been "dissected by B. Horsford, of Springfield.")

ANDESITE.

1876. **Andesite.** Pelham.

Closely associated with a shining red-brown biotite in loosely aggregated scales. The andesite is in large highly crystalline individuals, and is intimately associated with similar individuals of corundumite, though the latter are of infrequent occurrence. (SiO_2 , 57.20; CaO , 8.7.)

C. U. Shepard: Contributions to Min. (private publication), p. 4.

1883. **Andesite.** Pelham asbestos mine.

Sections cut from the specimen analyzed by Professor Shepard parallel to the axes gave extinction $-4-5^\circ$ on $0 P$ and $-13-14^\circ$ on $\infty P \infty$, which agrees with andesite, or a form between andesite and labradorite. The compact specimens named by him andesite are mostly anorthite, and are distinguished from those named anorthite by him only in the presence of disseminated biotite. It is all well advanced in decomposition, being much dusted with muscovite. It contains zircon. Nearest the tourmaline the mass is finest grained, white, free from biotite, and nearly all anorthite; farther away the grain gets coarser and the andesite increases gradually. Its twinning bands are broad, equally thick, and continuous. Other egg-shaped masses in the massive biotite, but farthest from the central mass, were very fresh and limpid and often gave conchoidal fracture. They gave an extinction on P of -1.30 , and were thus intermediate between andesite and oligoclase—an interesting gradation from the basic anorthite near the olivine to the oligoclase near the acid gneiss.

ANGLESITE.

1811. **Sulphate of lead.** Loudville.

In plates or tables on cubes of galena and in cavities in quartz.

William Meade: Bruce's Am. Min. Jour., Vol. I, p. 150.

1811. **Muriate or carbono-muriate of lead.** Loudville.

With description; very light green; groups of a cubic form terminated by tetrahedral pyramids; slightly affected by nitric acid.

William Meade: Bruce's Jour., Vol. I, p. 151.

1823. **Carbonated muriate of lead.** Loudville.

Same, above quoted.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 234.

1823. **Sulphate of lead.** Loudville.

Meade's description (1811) quoted.

E. Hitchcock: Geol. of Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 234.

1835. **Sulphate of lead.** Loudville.

Small plates on galena.

E. Hitchcock: Geol. Mass., p. 508.

1835. **Murio-carbonate of lead.** Loudville.

Same, above quoted.

E. Hitchcock: Geol. Mass., p. 507.

1835. **Corneous lead.**

C. U. Shepard: Min., Vol. I, Part II, p. 149.

Not mentioned in third edition.

1841. Murio-carbonate of lead. Loudville.

Previous account repeated.

E. Hitchcock: Geol. Mass., p. 705.

1841. Sulphate of lead. Loudville.

In small plates on galena.

Ibid., p. 705.

1865. Phosgenite. Southampton. Loudville.

Suggests that the stolzite here described by him under the name scheelite may have been mistaken for cerasite (phosgenite or mendipite) or matlockite, one or the other of which, under the old name of muriate of lead, has been supposed to exist at this locality.

C. U. Shepard: On scheelite; Am. Jour. Sci., 2d series, Vol. XLI, p. 215.

The above suggestion can not be accepted, because stolzite is decomposed by nitric acid. The original mineral described by Meade can not have been phosgenite, which dissolves with effervescence in dilute nitric acid. Almost all the points given in the description of Meade agree with anglesite. The crystals of anglesite found here are often superficially green from copper. It is described further as vitreous, nearly the luster of a precious stone, glassy fracture, brittle, melts to orange mass with lead globules, formed on galena, and but slightly acted upon by nitric acid. All these points agree with anglesite, and only the crystalline form remains; "in cubic form terminated by tetrahedral prisms." It will be noted further that no one has ever found the mineral since Meade's description, but all have copied him. I found in 1885 (in the Clark collection of Smith College, which has the finest series of crystals from the Loudville mine) specimens which agreed also in crystallization. They are an exceptional form of anglesite and appear in grouped prismatic aggregates up to 10 mm. in length, surmounted by acute pyramids, and resembling acicular aragonite. At times the aggregated prisms are finely striate longitudinally, changing the resinous luster to satiny. It is translucent, colorless to slightly amber.

A fragment of a crystal treated with HNO_3 was only slightly affected. Before the blowpipe it turns yellow, decrepitates, and with soda gives lead globules and test for sulphur.

1866. Cotunnite. Southampton lead mine.

Found in four specimens by Mr. P. W. Lyman; small groups lining quartz; right rhombic prisms, milk-white, opaque, soluble.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 247.

1885. Anglesite.

All the specimens upon which the above determination was made have passed through my hands, and are anglesite of very simple crystalline form. The best specimen—a large mass of quartz with many crystals—was burned with the Shepard collection. The second best piece has since been presented to the college by the finder, Rev. P. W. Lyman. Several other specimens are in the J. Clark collection of Smith College.

The following observations were made by me on the specimens presented by Rev. P. W. Lyman and determined by Professor Shepard, and also on others labeled by Mr. J. Clark as determined by Professor Shepard: Crystals in right rhombic prisms $\propto P$, $0P$ —largest, $1\frac{1}{2}$ mm. long, $\frac{3}{4}$ mm. wide—scattered over the surface of quartz in cavities in quartz or cerussite; color snow-white, opaque. In a single instance the face of another prism appears about $\propto P\bar{2}$; base striated parallel to long diagonal; prisms horizontally striated; broken crystals show the interior to be translucent and of resinous luster; prism faces slightly barreled and composite, the larger

1885. **Anglesite**—Continued.

crystals at times grouped and radiating like stilbite; small crystals transparent at the ends; average of many varying measurements, $I \wedge I$, $76^{\circ} 30'$ (anglesite = $76^{\circ} 16\frac{1}{2}'$).

No trace of solubility could be detected. Chlorine and lead were tested for in vain in the water in which the crystal had been boiled; as also in the nitric-acid solution. Before the blowpipe it turns yellow, decrepitate; with soda gives globules of lead and strong test for sulphur.

ANKERITE.

1825. **Carbonate of iron.** Cummington.

At rhodonite locality; laminated masses; not large.

E. Hitchcock: Loc. Min.; Am. Jour. Sci., 1st series, Vol. IX, p. 22.

1825. **Carbonate of iron.** Plainfield.

Beautiful crystals; rhombs nearly white, curved faces.

J. Porter: Ibid., Vol. IX, p. 54.

1827. **Carbonate of iron.** Charlemont, Hawley, Chester.

J. Porter: Min. Not.; ibid., Vol. XII, p. 378.

1835. **Ankerite.** West Springfield.

See Dolomite.

1841. **Carbonate of iron.** Cummington.

In boulders of manganese ore.

E. Hitchcock: Geol. Mass.; Final Rept., p. 613.

1892. **Ankerite.** Hawley, Charlemont.

The following analyses represent the composition of the carbonate so abundantly disseminated in the Hawley schists.

No. 1, by L. G. Eakins, of the United States Geological Survey, is from a chlorite-schist in which the coarsely granular carbonate is disseminated like the feldspar in a gneiss. It is from a point just south of the road running over Forge Hill, in Hawley, near the first mine in the pasture of M. V. Cressy.

No. 2, also by Mr. L. G. Eakins, is from quite large rhombohedra of the same mineral in chlorite-schist from the hill a mile north of the hotel in Charlemont.

No. 3 is by Mr. C. L. Upton, class of '91, in Amherst College, and is the mean of two analyses. It is from the fine large rhombohedra found in chlorite-schist in Hawley, in the gorge near the mill, opposite the town hall.

	No. 1. *	No. 2.	No. 3.
SOI ₂	3.87	.67	3.77
Al ₂ O ₃	2.72	Trace.	CaO { 10.98
Fe ₂ O ₃	1.75	.08	MgO { 11.23
FeO	1.34	7.60	7.40
MnO	.05	1.61	.....
CaO	3.34	28.63	27.62
MgO	4.50	16.17	15.87
K ₂ O	.19	(NiO .03)	.....
Na ₂ O	.15	.....	.....
CO ₂	4.51	45.35	43.13
	22.82	100.14	100.00

* Soluble in HCl.

† Gangue.

‡ Loss.

This gives for No. 2 the formula $\text{CaCO}_3 + \text{FeCO}_3 + 2\frac{1}{6} (\text{CaMgC}_2\text{O}_6)$.

ANHYDRITE.

1892. **Anhydrite.** Northampton.

Larrabee's quarry, beside the Connecticut River, on the north line of Holyoke. A very exceptional and interesting occurrence of anhydrite has just come to my knowledge. Its geological significance will be discussed in the monograph on the geology of the area. Within a small space, a foot or two beneath the surface of the trap mass exposed in the quarry, the large irregular cavities in the trap, 1 to 2 inches thick and 3 or 4 inches in the other dimensions, are filled (instead of with calcite, as is usual) with the finest bluish anhydrite. It is in tabular masses, precisely like the Chesterfield cleavelandite.

The tabular aggregates are generally slightly radiated, and the plates reach 2 or 3 inches in length. They at times radiate so rapidly in smaller plates that the latter curve 90° in a single inch. The plates vary in width from an eighth of an inch down to extreme fineness, are bounded by nearly parallel planes, but taper slowly to an edge, and are replaced by the thickening of their neighbors. The planes bounding these plates are parallel to $\infty P \propto (010)$. As a result of this structure a mass broken across the face of perfect cleavage $0 P (001)$ closely resembles in luster and habit the striated prism faces of apophyllite, the cleavage is so exceptionally perfect. It resembles even more closely the triclinic striation of albite when the latter structure is coarsely developed. Sections including several plates cut parallel to $0 P$ polarize as units and show the obtuse bisectrix.

Sections parallel to $\infty \bar{P} \propto (100)$ show the same partings and give the axial figure in the same position on all the bands; so there is no twinning.

Sections parallel to $\infty P \propto (010)$ do not extinguish entirely. They show a decided cleavage parallel to $P \propto (101)$, along which the mineral often separates readily.

One cavity showed traces of fibrous, finely striated crystals.

The surface of the outflowing trap sheet was covered with mud while still plastic, and trap and shale are confusedly mingled. There is much pyrite in the trap and much secondary calcite in the cavities, often with the anhydrite.

ANORTHITE.

1876. **Anorthite.** Pelham.

"Found abundantly at the asbestite mine of Pelham. Massive, granular to compact; color grayish, yellowish, or pinkish white. It is the indianin variety of the species and contains 19.4 of CaO."

C. U. Shepard: Contrib. to Min. (priv. pub.), p. 4, and Cat. of Min. within 75 miles of Amherst College, p. 5.

1876. **Anorthite.** Pelham.

The following analysis was made by Mr. Josiah Keep, of the class of '74, Amherst College: The material was taken from the opaque white, fine granular variety nearest the olivine rock. The specimen was one labeled anorthite by Professor Shepard:

SiO ₂	48.87
Al ₂ O ₃ (dif)	36.76
CaO	10.82
K ₂ O	1.35
Na ₂ O	2.20
	100.00

1882. **Anorthite.** Pelham. Asbestos mine.

Some well-formed small crystals occur implanted in tourmaline—albite twins with few faces.

1883. **Anorthite.** Pelham. Asbestos quarry.

The fine white compact mass nearest the tourmaline (Shepard's type) gives extinction in twin laminae 25° to 38° , and so is probably anorthite. The crystals are almost simple, with very minute interspersed laminae in two directions at right angles. It is much decomposed into muscovite, and carries zircon, and is mixed with andesite.

1892. **Anorthite.**

The feathery porphyritic groups of first consolidation in the diabase uniformly show the optical characters of anorthite.

ANTHRACITE.

1835. **Anthracite.** Turners Falls, in Gill; at the Southampton lead mine, in Triassic sandstone.

E. Hitchcock: Geol. Mass., p. 227.

1841. **Anthracite.** Above repeated.

E. Hitchcock: Geol. Mass., Final Rep., p. 137.

ANTHOPHYLLITE.

1818. **Asbestos.** Pelham.

Compact.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. **Asbestos.** Pelham.

With serpentine and talc.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 225.

• 1824. **Compact asbestos.** Pelham.

C. U. Shepard: Min. Loc.; *ibid.*, Vol. VIII, p. 235.

1870. **Asbestos.** Pelham.

Land of Mr. Samuel Newell; recent excavations for economical purposes prove it inexhaustible.

J. H. Adams, class of '70, Amherst College: Am. Jour. Sci., 2d series, Vol. XLIX, p. 271.

1876. **Asbestite.** (Shepard.) Pelham.

Fibrous and hard; sp. gr., 2.9 to 3.

SiO ₂	59.40
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MgO	30.60
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FeO	7.60
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H ₂ O	1.56
------------------------	------

Al ₂ O ₃ CuO	Trace.
--	--------

99.6

Compact and subslaty; sp. gr., 2.93.

SiO ₂	58.91
------------------------	-------

MgO	29.37
-----------	-------

FeO	9.37
-----------	------

HO	3.37
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Al and Ca	Trace.
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100.92

C. U. Shepard: Min. Cont. (priv. pub.), p. 3.

1876. **Asbestite.** Pelham.

C. U. Shepard: Cat. Min., 75 miles of Amherst College, p. 3.

1877. **Asbestoid bronzite.**

After quoting the two analyses of "asbestite," given above, Shepard says, "They are both undoubted varieties of bronzite. The fibrous variety exactly resembles this species from Aloystha (Aloysthal), in Moravia, except in wanting the dark color and bronzy luster of the Moravian mineral and in having, through partial decomposition, a somewhat lower hardness. The peculiar oblique cross cleavage of the fibers from both localities is very strikingly similar. The common, coarsely granular bronze variety is also found in small quantity at Pelham, diffused through rounded masses of considerable dimensions of the peculiar mineral named by me Pelhamine. These masses are enfolded in the closely contiguous biotitic schist.

C. U. Shepard: Contrib. to Min., p. 4; Amherst, May 11, 1877.

1893. **Anthophyllite.** Pelham.

In the geological monograph the "asbestos" of the Pelham asbestos mine is discussed and its derivation from olivine established. This fibrous asbestiform mineral is a secondary one, being derived from the olivine rock and growing out from fissures which form a great network in the latter, in fibrous masses set transversely to these fissures which remain as central sutures to the new growth, so that the whole repeats on a large scale the microscopic decomposition of olivine. On the other hand, the bronzy mineral mentioned above by Professor Shepard is a true bronzite—an original constituent of the olivine-enstatite rock.

The fibrous mineral was proved to be anthophyllite by its uniform longitudinal extinction and by finding larger blades, measuring $54^{\circ} 30'$ to 55° .

1894. **Asbestos.** Pelham.

C. Hinze, p. 1231.

ANTIMONITE.

1822. **Sulphuret antimony.** Near South Hadley.

Cleveland's Min., Vol. II, p. 688.

This occurrence has not been verified.

APATITE.

1824. **Phosphate of lime.** Chester.

In an aggregate of gray epidote, zoisite, hornblende, and quartz. Dissolves slowly in NO_5 . Whitish-yellow. Fragments transparent. Form a rectangular prism.

E. Emmons: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VII, p. 254.

1824. **Phosphate of lime.** Chester.

Disseminated in granite. Also the variety apatite in yellowish-green crystals and granular masses phosphoresces on hot iron with pale-yellow light; also in mica-slate in roundish masses. Its powder digested in H_2O changes vegetable blue to green (Emmons).

C. Dewey: Geol. Berkshire Co.; *ibid.*, Vol. VIII, p. 36.

1825. **Phosphate of lime.** Williamsburg.

"July, 1824. This mineral was forwarded to me in June last by Morris Dwight, its discoverer. It is embedded in a rock of gneiss. * * * Color delicate straw yellow, pale green, greenish white, apple green. Large 6-sided prisms more than 1 inch in length terminate by flat plane."

B. Silliman: Notice of a mineral supposed to be phosphate of lime from west Massachusetts; Am. Jour. Sci., 1st series, Vol. IX, p. 174.

1827. **Asparagus stone.** Williamsburg, in granite.

Prisms several inches long; and another variety of phosphate of lime in mica-slate in grains.

A. Nash: Lead mines of Hampshire County; *ibid.*, Vol. XII, p. 260.

1835. **Apatite.** Williamsburg, Chesterfield, Chester, Middlefield, Norwich, Conway.

In Williamsburg, hexagonal, delicately green crystals; in Norwich, in gray quartz and black mica near granite. One crystal 6 inches long by 3 inches across.

E. Hitchcock: *Geol. Mass.*, p. 343.

1841. **Apatite.** Williamsburg, Chesterfield, Chester, Middlefield, Norwich.

Williamsburg, hexagonal, delicately green; Chesterfield, with kyanite. Resembles chrysoberyl in appearance. Norwich, in gray quartz, with black mica, near granite. One imperfect crystal (No. 728, State collection) 3 inches in diameter, 6 inches long.

E. Hitchcock: *Geol. Mass.*, p. 604.

1844. **Apatite.** (*Fluellus hexagonus*.) Norwich, Chester, Chesterfield, and Williamsburg.

J. D. Dana: *Sys. Min.*, p. 238.

1876. **Apatite.** Pelham, Huntington.

C. U. Shepard: *Cat. of Min. within 75 miles of Amherst College*, p. 2.

1879. **Apatite.** Walnut Hill, Huntington.

In tourmaline granite veins.

A. A. Julien: *Ann. N. Y. Acad. Sci. Arts*, Vol. I, p. 352.

1883. **Apatite.** Pelham asbestos quarry.

An exquisite 6-sided prism one-half inch long, green at ends and down middle apparently, but satiny white on faces, and with plumose surface. Given me by Mr. Thompson for mineral collection of Amherst College.

1885. **Apatite.** Rowe.

Small light-green crystals in pyrites at the mine of J. M. Davis & Co.

A. G. Dana: *Gahnite at Rowe*; *Am. Jour. Sci.*, 3d series, Vol. XXIX, p. 455.

1891. **Apatite.** Pelham.

The new working of the asbestos mine has furnished many beautiful crystals. They are embedded in the biotite fringe rock, with nodules of hornblende and corundum, and in the massive tourmaline. They are transparent, rich oil-green. The form is a short, stout prism with flat ends. The largest was 3 inches long and 2 wide, showing the faces ∞P , $0 P$, P , $\infty P 2$. Some are weathered through and through to opaque white, like the Snarum crystals.

1895. **Apatite.** Chester.

Occurs in small, pale-green crystals with corundophyllite, in the Chester emery vein.

ARAGONITE.

1825. **Aragonite.** Middlefield.

Yellow, transparent. $H. = 4$; sp. gr., 2.39. Dissolved in nitric acid with effervescence. Exactly resembled the Bilin crystals, with rhombspar in steatite, found by Dr. Emmons.

C. U. Shepard: *Bost. Jour. Phil.*, Vol. III, p. 609. (The sp. gr. changed to 3.93 in Professor Shepard's copy of the Journal.)

1887. Aragonite. Chester emery mine.

Beautiful crystals, of the usual acicular type and 20 mm. long, occur coating fissures; also in radiated tufts; the best specimens in the cabinet of the late Mr. Ames, of Chicopee.

ARSENOPYRITE.**1823. Mispickel** (arsenical iron?). Gill.

Boulder of several pounds. Dr. Alpheus Stone.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 232.

1876. Arsenopyrite. Bernardston.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 8.
[Probably exists only in boulders.]

ASBESTOS.

See Anthophyllite and Amphibole.

ASTROPHYLLITE.**1866. Astrophyllite.** Northfield.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

See Biotite.

AUTUNITE.**1835. Uranite.** Chesterfield, Mass.

At tourmaline vein. Crystalline plates and pulverulent. Emerald green (Mr. Shepard).

Ed. note: Am. Jour. Sci., 1st series, Vol. XXVIII, p. 382.

1841. Uranite. Chesterfield.

Found by Professor Shepard in small quantity.

E. Hitchcock: Geol. Mass., p. 704.

1841. Uranite. Chesterfield.

J. E. Teschemacher: Proc. Bost. Soc. Nat. Hist., Vol. I, p. 15 (abstract);
Bost. Jour. Nat. Hist., Vol. IV, p. 35.

1844. Uranite. (*Uranalus quadratus*). Chesterfield.

Discovered by Teschemacher in centers of red tourmalines.

J. D. Dana: Min., 2d ed., p. 297.

1845. Uranite. Chesterfield.

Prof. C. U. Shepard claims priority over Teschemacher of discovery of uranium at Chesterfield.

Am. Jour. Sci., 1st series, Vol. XLVIII, p. 179.

1845. Uranite. Chesterfield.

Maintains claim to priority of discovery of uranite on ground that the publication of the Proceedings of the Boston Society of Natural History was April, 1841; that of Professor Hitchcock's Geology of Massachusetts, to which Shepard refers, was in November, 1841.

J. H. Teschemacher: Am. Jour. Sci., 1st series, Vol. XLVIII, p. 395.

1868. Autunite. Chesterfield.

In minute crystals on the quartz or albite, and sometimes in the red centers of tourmalines.

J. D. Dana: Min., p. 587.

1879. **Autunite.** West Chesterfield.

On cleavage planes of spodumene, derived from alteration of zircon containing uranium.

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 354.

AXINITE.

1819. **Augite.** Deerfield.

"In an aggregate of greenstone, quartz, and calcareous spar in the greenstone range of Deerfield. Color black, and the crystals usually imperfect or broken."

E. Hitchcock: Supp. Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. II, p. 436.

1823. **Augite.** Deerfield.

In irregular veins or imperfect crystals.

E. Hitchcock: Geol. Conn. River; ibid., Vol. VI, p. 225.

1835. **Augite.** Deerfield.

"Is of an iron-black color and in imperfect crystals or in veins; is sometimes met with in the tufaceous greenstone of the Connecticut Valley, as at a spot 1 mile east of the village of Deerfield."

E. Hitchcock: Geol. Mass., p. 435.

1841. **Augite.** Deerfield.

Same as 1835.

E. Hitchcock: Final Report on Geol. Mass., p. 661.

1882. **Axinite.** Deerfield; cut on canal railroad. South of the Deerfield River, at Cheapside.

Jet-black opaque crystals, the largest 10 to 12 mm. in length, embedded in prehnite, and calcite resting on prehnite. The crystals are thick plates, resembling, as do many of the minerals found here, the simpler forms from Bourg d'Oisins—the faces $P \infty (1\bar{1}0)$, and $P' \infty (110)$, large and striated vertically, and $P \infty$ striated horizontally parallel to the intersection edge of $P \infty$ and $P (1\bar{1}1)$. The face P is smaller and striated horizontally. Rarely the faces $\infty P \infty (010)$, $\infty P \infty (100)$, and $2 P \infty (201)$ appear. Two very distinct distant cleavages, especially clear under the microscope, parallel to the two striations upon P , and nearly at right angles to this face, thus nearly cubical. Thin splinters show brilliant trichroism, deep bottle-green, plum-blue, and clove-brown, and are glassy and easily transparent under the microscope, and entirely free from all impurities. The mineral has occurred also at the old locality east of Deerfield village, and appears in the State collection, Nos. 86, 87, labeled "Black augite in greenstone, Deerfield." I found also opposite Turners Falls a single perfect crystal 4 mm. long, black, with shade of brown, resting upon a botryoidal layer of diabantite in an amygdale. Some of the finest crystals of axinite occur in the datolite. The crystals are here sometimes short, stout prisms.

B. K. Emerson: The Deerfield Dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 350.

AZURITE.

1881. **Azurite.** Leverett.

With malachite in small portions, at new opening of upper Leverett mine.

1887. **Azurite.** Southampton lead mine.

Occurs surrounding chalcopyrite and intermixed with massive black copper oxide, also in thick coatings on quartz. Rare. Specimens in Clark collection of Smith College.

1890. **Azurite.** Chester.

In hornblende-schist at the main shaft of the emery mine.

BABINGTONITE.1892. **Babingtonite.** Buckland.

Coating vertical north-and-south fissures in Cambrian gneiss at quarry beside railroad, near Shelburne Falls.

Broad surfaces are covered with a jet-black granular layer, which at times shows crystal faces. Dissolving away a layer of calcite, small crystals were exposed, with strongly striated faces of high luster, and having entirely the habit of babingtonite. The minuteness of the crystals and the striation prevented accurate measurement, but the following numbers were obtained:

	<i>Found.</i>	<i>Calc.</i>
$c \wedge d$	56°	$57^{\circ} 36'$
$c \wedge M$	$87^{\circ} 10'$	$87^{\circ} 28'$
$c \wedge m$	$67^{\circ} 20'$	$67^{\circ} 48'$
$c \wedge g$	$47^{\circ} 20'$	$47^{\circ} 36'$

$$c = (001) \cap P \quad d = (2\bar{2}1) \cap 2'P.$$

$$M = (1\bar{1}0) \cap P \quad m = (110) \cap P'.$$

$$g = \bar{1}\bar{1}1 P.$$

c , g , and m are striated parallel to their intersection; d and M the same.

The following analysis was made in the laboratory of the Survey by Mr. E. A. Schneider. The material was in part brownish from the beginning of decomposition, which explains the large per cent of water:

SiO ₂	52.48
TiO ₂	Trace.
Al ₂ O ₃	1.93
Fe ₂ O ₃	¹ 23.24
FeO	(²)
MnO	.37
MgO	1.55
CaO	19.31
K ₂ O	(³)
Na ₂ O	(³)
H ₂ O (105°)	.11
H ₂ O (above 105°)	1.03
P ₂ O ₅	(³)
B ₂ O ₃	(⁴)
	100.02

The mineral is intergrown with fine, small crystals of epidote, natrolite, chabazite, and quartz. The development of the faces is such that the crystals resemble axinite. On discussing the analysis Prof. F. W. Clarke pronounced the mineral babingtonite.

BARITE.1810. **Barite.** From Southampton lead mine.

B. Silliman: Bruce's Min. Mag., Vol. I, p. 64.

¹ Includes FeO.

² Not determined, owing to lack of material.

³ Not determined.

⁴ Spectroscop. good reaction.

1818. **Barite.** Greenfield.

Bank of Connecticut River; walls of copper vein, 1 inch to 1 foot on wall; vein, 6 to 8 feet.

E. Hitchcock: Geol. Deerfield, etc.; Am. Jour. Sci., 1st series, Vol. II, p. 115.

1822. **Barite.** Hatfield, Mass.

Sp. Gr., 4.28.

BaO	58.50
SO ₃	29.83
SiO ₂	4.00
Al ₂ O ₃	2.00
H ₂ O	3.00
	97.33

Dr. Gorham: Cleaveland's Min., Vol. I, p. 137.

1823. **Barite.** Hatfield (Gorham), Middlefield (Eaton). Southampton, Leverett, Greenfield copper vein—in all lamellar.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 211.

1827. **Barite.** Leverett.

Vein in granite 1 mile northwest of meetinghouse on land of Mr. Field; 1½ miles south on an eminence of granite; Hatfield, one-half mile west of town, vein in sienite; Williamsburg, east part; Whately.

A. Nash: Lead mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 249.

1832. **Barite.**

"I have been in the habit for several years of having various articles in the laboratory covered with it, and it answers a good purpose. Mixed with boiled linseed oil and lampblack, it is superior to anything I have found for labeling glass bottles in the laboratory."

E. Hitchcock: Geol. Mass.; Am. Jour. Sci., 1st series, Vol. XXII, p. 48.

1841. **Baryta.** Southampton, Leverett.

Abundant in granite, in veins.

E. Hitchcock: Geol. Mass., p. 700.

1885. **Barite.**

Other localities of barite are many small veins in granite in field north of South Leverett lead mine, and at the railroad cutting south of the crossing east of the same mine.

1885. **Crystallized quartz.** Quartz pseudomorph after barite. Norwich (Huntington).

The specimens labeled crystallized quartz, XIX 204-209, in the State geological collection now at Amherst College, from Angel's mine, are pseudomorphs in plates 1 to 3 inches square.

1885. **Barite.** Titan's Piazza, Mount Holyoke.

Members of the class of '85 of Amherst College found quartz pseudomorphs after barite in much fissured amygdaloidal rock from the upper portion of the great diabase sheet, in masses fallen from the cliffs above Titan's Piazza. The barite had coated the fissures on both surfaces with a drusy layer about 3 mm. thick, made up of tabular crystals 1.5 mm. across. The cavity was then filled with slightly amethystine radiating quartz, and later the barite was itself replaced by quartz. The crystals are tabular 0 *P* (001), *P* ∞ (101), *P* ∞ (011). The rough faces gave only approximate measurements: 0 *P* ∧ *P* ∞ 51°-53°, calculated 52° 43'; 0 *P* ∧ *P* ∞ 57°, calculated 58° 10'.

1886. **Barite.** Northampton.

At granite quarry, south of W. N. Moore's, east of Florence, (1) in broad, large, and extremely thin crystals; pseudomorphs of quartz after barite; (2) in thicker incrustation pseudomorphs, also quartz after barite; and (3) compact barite, filling fissures 10 to 20 mm. wide.

1878. **Barite.** Florence, Northampton.

In veins in granite at the bridge and dam south of the brush factory.

1892. **Barite.** Northampton.

Larrabee's quarry in diabase on the Connecticut River Railroad above Holyoke.

The calcite filling fissures contains cavities from which thin tabular crystals of barite an inch square have been removed.

BASTITE.

1821. **Talc.** Russell.

A dark-colored serpentine containing scales of talc. Specimen sent by Dr. William Atwater.

Am. Jour. Sci., 1st series, Vol. III, p. 238.

1824. **Metalloidal diallage (?)**. Middlefield.

In serpentine.

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 49.

1825. **Schiller spar.** Blandford.

In serpentine, associated with anthophyllite. Shining folia olive to black. (The anthophyllite is enstatite.)

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 608.

1832. **Green talc.** Russell.

E. Hitchcock: Geol. Mass.; *ibid.*, Vol. XXII, p. 30.

1832. **Kerolite.** Blandford.

A leek-green and blackish-green variety in curved and stellular laminæ engaged in schiller spar.

SiO ₂	40.0
MgO	41.4
CaO	0.932
FeO	2.70
H ₂ O	15.67
	100.702

C. U. Shepard: Min., Vol. I, Part II, p. 292.

1835. **Schiller spar (?)**. Blandford.

Boulders in the eastern part of Blandford, of a peculiar green serpentine, contain talc and schiller spar.

E. Hitchcock: Geol. Mass., p. 369.

1835. **Schiller spar.** Blandford.

C. U. Shepard: Min., Vol. II, Part II, p. 177.

1841. **Schiller spar.**

"The dark-green schiller spar found in serpentine in Blandford, Westfield, Russell, occurs in foliated masses."

E. Hitchcock: Geol. Mass., p. 618.

1841. **Schiller spar.**

The serpentine, as well as the schiller spar, is almost black, while the talc is green and somewhat brittle. Occurs only in Blandford, Russell, and Westfield.

Ibid., 1841, p. 615.

1844. **Schiller spar.** Blandford and Westfield.

F. Alger: Phillips, Min., p. 95.

1852. **Marmolite.** Blandford.

Dark-green variety.

C. U. Shepard: Min., Vol. I, Part II, p. 292.

1871. **Bastite.** Russell.

Optical axial angle 30° .

G. Tschermak: Ueber Pyroxene und Amphibole; Tschermak's mineral.

Mittheil., Vol. I, p. 20 (4).

1876. **Serpentine.** Variety, marmoline. Russell, Blandford.

[Schiller spar not mentioned.]

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 3.

1876. **Phaestine.** Pelham.

On labels by Professor Shepard in Shepard collection, Amherst College.

It is altered bronzite in black chrysolite rock from the asbestos mine.

1885. **Bastite.** Russell.

The blackish portions of the Russell serpentine from Atwater's quarry are in part still enstatite, in part are optically bastite, colored black by magnetite, and the latter portions do not differ from the leek-green plates first called marmolite by Shepard, except in the presence of disseminated magnetite in the former and its absence in the latter.

BERYL.

1813. **Emerald.** Chesterfield.

Dr. J. F. Waterhouse says crystals in hexagonal prisms, from an ounce and under up to 6 pounds, are found in granite. They occur up to a foot in diameter; color, light-green. He got 70 pounds.

Dr. Bruce: Bruce's Jour., Vol. 1, p. 264.

1813. **Emerald.** Vicinity of Northampton and Goshen.

"Found by that indefatigable mineralogist, Dr. David Hunt."

Ibid.

1819. **Emerald.** Chesterfield.

Crystals 3 to 5 inches long and $3\frac{1}{2}$ inches in diameter; summit, a plane without additional facets, is perfect.

Col. G. Gibbs: On tourmalines, etc., at Chesterfield; Am. Jour. Sci., 1st series, Vol. I, p. 348.

1819. **Emerald.** Goshen.

Beautiful pale-rose, rather more transparent than the emerald.

Ibid., p. 351.

(This is the first mention of the "goshenite.")

1822. **Beryl.** Chesterfield.

Up to 1 foot in diameter, usually light-green (Bruce's Min. Jour.) Goshen. Two rose-colored emeralds are now in the cabinet of Colonel Gibbs; perfect crystals 1 to $1\frac{1}{2}$ inches in length, 1 to $1\frac{1}{4}$ inches in diameter, one truncated on lateral edges. (Gibbs.)

Cleveland: Min., p. 344.

1823. Beryl. Chesterfield and Goshen (Gibbs).

At Chesterfield the crystals are sometimes from 9 to 12 inches in diameter. At Goshen some are rose-colored.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 222.

1824. Beryl. Near Goshen Center.

Found with white augite on north road from Goshen Center, more than 1 inch in diameter.

Ibid., Vol. VII, p. 30.

(The "white augite" is spodumene.)

1824. Beryl. Norwich, Chester.

One-half mile west from Pitchers Bridge, Norwich (now Huntington), near mass of white rocks to be seen from the bridge; one crystal 5 inches in diameter and crossed by another at 45°.

Chester, in aggregate of carbonate of lime, chlorite, and feldspar. Yellowish-green to white.

E. Emmons: Min. Loc.; Am. Jour. Sci., 1st series, Vol. VII, p. 254.

(The second citation is problematical. This aggregate occurs at the emery mine associated with long, yellowish-green prisms of epidote.)

1824. Beryl.

Six-sided prisms and amorphous. Often fine, delicate green; up to 5 inches in diameter. In granite in Chester and Norwich (Emmons). Also in similar and larger crystals in Worthington, sometimes whitish.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 43.

1825. Topaz (?). Goshen.

"Portion of a crystal nearly an inch in diameter, perfectly limpid, although when lying in its bed it has a delicate green tinge which is occasioned by the greenish crystals of mica which lie around. Fracture in one direction straight, in others conchoidal."

E. Hitchcock: *Ibid.*, Vol. IX, p. 180.

(Afterwards called goshenite.)

1825. Pyrophysalite.

"Dr. Wright, of Goshen, pointed out to me a mineral at the locality of indicolite, etc., which he informed me was denominated by Mr. Nuttall the variety of topaz described by mineralogists under the above name. Its color is white, tinged with green, and on hot iron it phosphoresces very distinctly with a yellowish-green light and loses its color. It is opaque, or only slightly translucent. It is distinctly crystallized, but from the few specimens I obtained I could not determine the form."

E. Hitchcock: Loc. Min., Am. Jour. Sci., 1st series, Vol. IX, p. 21.

(Afterwards called goshenite.)

1825. Iolite (?). Goshen.

From the Barrus locality. Full description given.

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 395.

1825. Beryl. Norwich (Huntington). In the north part of the town.

In granite, a locality extraordinary for the regularity, transparency, and fine green color of the crystals, which occur from one-fourth to 4 inches in diameter. One superb crystal found in the earth near by 4½ inches in diameter and 6 inches long, with smooth and brilliant faces and rich green color.

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 607.

(This crystal was destroyed with the Shepard collection.)

1827. **Beryl.** Goshen, Chesterfield.
In granite veins, 2 to 3 inches in diameter and 5 to 6 inches long.
A. Nash: Lead mines of Hampshire County; *ibid.*, Vol. XII, p. 259.
1828. **Beryl.** Norwich (now Huntington).
"Sought location" one-half mile west of Pitchers Bridge, near mass of white rocks to be seen from the bridge, described in Robinson's Catalogue.
No such white rocks can be seen west of the bridge, but a conspicuous, protruding mass of granite to the north; in this only one or two crystals of beryl occurred. It appeared also near the north line of the town.
E. Hitchcock: *Min. Ex.*; *Am. Jour. Sci.*, 1st series, Vol. XIV, p. 219.
1835. **Beryl.** Chesterfield.
One foot in diameter.
E. Hitchcock: *Geol. Mass.*, p. 506.
1838. **Phenakite.** Goshen.
"My first knowledge of the American mineral, which I take to be phenakite, was acquired about fourteen years ago, during a visit to the tourmaline locality in Goshen (on the farm of Mr. Weeks) in company with Mr. Nuttall and the late Dr. Hunt, of Northampton. My first impression was that it belonged to iolite, an opinion I afterwards changed in favor of the species beryl, under which name, I believe, it has generally passed in cabinets ever since. It should be remarked, however, that it was referred by some collectors for a time to topaz." Described.
C. U. Shepard: *Am. Jour. Sci.*, 1st series, Vol. XXXIV, p. 330.
(Afterwards called goshenite.)
1841. **Beryl.** Pelham.
In gneiss in Pelham; a rather handsome yellow beryl; not abundant.
E. Hitchcock: *Geol. Mass.*, p. 638.
1841. **Beryl.** Goshen, Chesterfield, Norwich.
"Many localities which yield few and not rich specimens." Several places in Goshen.
At the Weeks farm occurs a mineral of a rose color, but usually hyaline, which was formerly described as a rose beryl. Professor Shepard has, however, more recently described this mineral as the phenakite.
Am. Jour. Sci., 1st series, Vol. XXXIV, p. 330.
Dr. F. Tamnau, of Berlin, Prussia, to whom I sent specimens, says that "it seems not to be identical with the phenakite from the Ural and from Tramont [Framont], and I wish particularly to have more of it for a chemical analysis."
Chesterfield and Norwich. Beryls of great size, but poor; Norwich. In northwest part, very good; in Williamsburg and Worthington, quite elegant; also Warwick.
E. Hitchcock: *Geol. Mass.*, p. 703.
1842. **Phenakite.** Goshen.
"A new examination of the sp. gr. satisfies me that it is not phenakite; sp. gr., 275-276, too low for phenakite; slightly superior to beryl, also slightly harder."
C. U. Shepard: *Am. Jour. Sci.*, 1st series, Vol. XLIII, p. 366.
1844. **Goshenite.** Goshen.
C. U. Shepard: *Treatise Min.*, 2d ed., Part I.
1844. **Beryl.** (*Beryllus hexagonus*.) Goshen and Chesterfield.
J. D. Dana: *Sys. Min.*, p. 393.

1845. **Goshenite.** Goshen.

"I agree that goshenite, in the absence of well-determined crystals, rather than for the want of a good analysis (as you suggest), occupies a precarious position among my list of species."

C. U. Shepard: Reply to critique on mineralogy; *Am. Jour. Sci.*, 1st series, Vol. XLVIII, p. 174.

1845. **Goshenite.** Goshen.

"A crystal of this substance lately obtained by me at the locality shows so nearly the angles of beryl as to remove all probability that these minerals can be shown to be crystallographically distinct."

C. U. Shepard: Various mineralogical notices, *ibid.*, p. 176.

1854. **Goshenite.** Chesterfield.

Analysis proved it to be beryl.

J. W. Mallet: *Am. Jour. Sci.*, 2d series, Vol. XVII, p. 180.

1866. **Beryl.** Northfield.

One mile northeast of village, on land of Simeon Lyman. In vein of graphic granite in mica-schist. Abundant crystals up to 10 inches. Pale greenish-white; tabular, ∞ P, 0 P.

Also on Northfield Mountain on road to Irving, in southeast corner of the town.

C. U. Shepard: *Am. Jour. Sci.*, 2d series, Vol. XLII, p. 248.

1876. "**Berylite.** Variety, aquamarine. Chesterfield; rose-colored and white. (Goshenin) Goshen."

C. U. Shepard: *Cat. of Min. within 75 miles of Amherst College.*

In this publication Professor Shepard proposed a new nomenclature. The termination *in* was to be used for varieties not yet established as valid, *ine* for good varieties, *ite* for species. The system has not been adopted.

1877. **Beryl.** Blandford.

Dark-colored and poor. Field north of church.

1879. **Beryl.** Chesterfield.

At spodumene location, Barrus farm, near Goshen. Small green crystals in coarse masses at Chesterfield Hollow.

A. A. Julien: *Ann. N. Y. Acad. Sci. Arts.*, Vol. I, p. 319.

1882. **Beryl.**

Fine crystals have been found by Mr. J. T. Ames, of Chicopee, in the granite veins in the Monson quarry.

Mr. W. N. Flint, private communication.

1882. **Beryl.** Blandford.

A fine crystal 16 inches long and 12 inches in diameter was obtained at the feldspar quarry of the Pontoosuc flint mills and presented to the Amherst College cabinet by Mr. F. L. Nason.

1882. **Beryl.** Northfield.

In Brush Mountain at tourmaline locality. Crystals up to 3 inches across, bluish, oil-green to colorless; largest 13 inches across, 78 to 80 pounds; 0 P, ∞ P. In some the prisms are molded into points at one end by intercrystallization with muscovite. Also found at columbite locality at John Moody's and east of gulf road, in granite. Discovered by Mr. M. A. Brown.

Collection of W. E. Webster, Northfield.

1885. **Beryl.** Huntington, Norwich Hill.

In extensive blasting at the spodumene ledge, done for me by Mr. F. L. Nason, only a few small prisms and irregular pieces were found, molded among other minerals. Of a reddish-yellow color.

1890. **Beryl.** Goshen.

Rude crystals more than a foot across, in granite north of the brook entering Lily Pond. Discovered by Mr. Alvan Barrus.

1890. **Beryl.** Goshen.

Two beautiful rose-colored beryls, over an inch across, have been found at Goshen, Mass., and are in the Gibbs cabinet at Yale University.

George F. Kunz: Gems and precious stones of the United States, p. 92.

BIOTITE.

1823. **Macle.** Chesterfield.

"According to Mr. Nuttall, the foliated mineral occurring so abundantly in the mica-slate in Chesterfield, etc., being usually inserted in small bronze-colored plates nearly at right angles to the bedding, may be macle."

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 227.

1824. **Black mica.** Pelham.

Fine specimens.

C. U. Shepard: Min. Loc., *ibid.*, Vol. VIII, p. 235.

1838. **Black mica.** Brimfield.

Six-sided tables with iolite, good; $1\frac{1}{2}$ miles northeast of village, on Warren road, near Samuel Patrick's.

J. W. Foster: *Ibid.*, Vol. XXXIII, p. 400.

1841. **Mica.**

Described as a constituent of "spangled mica-slate," with expression of uncertainty as to its nature. Small bronze plates at right angles to bedding; brittle and inelastic.

E. Hitchcock: Geol. Mass., p. 594.

1852. **Ottrelite.** Near Goshen.

Abundant.

C. U. Shepard: Min., p. 161.

(This is the biotite forming the spangles of the "spangled mica slate.")

1866. **Astrophyllite.** Northfield.

"Black-lead mine," on land of Mr. Piper.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

(It is not cited in Shepard's Catalogue of Minerals of 1876, and is biotite. See 1886. Graphite, under GRAPHITE.)

1866. **Biotite.** Chester.

"I examined a specimen of the dark-green micaceous mineral which I took to be chlorite (the corundophyllite of Shepard), and from its purity expected to get a very accurate idea of its composition, but in the very commencement of the investigation it was found to be well-characterized biotite." Occurs on surface of indianite (Shepard) in small, thin, micaceous crystals perpendicular to surface; dark green.

1866. **Biotite**—Continued.*Analysis.*

SiO ₂	39.08
Al ₂ O ₃	15.38
MgO	23.58
FeO	7.12
MnO	0.31
K ₂ O	7.50
Na ₂ O	2.63
H ₂ O	2.24
Fl	0.76
	98.60

J. L. Smith: Am. Jour. Sci., 2d series, Vol. XLII, p. 91. This is the "fringe rock" mica afterward named euchlorite b. Shepard.

1868. **Phyllite** (Ottrelite). Goshen, Plainfield, Chesterfield.

Dana, Min., p. 506.

1870. **Corundophyllite**. Pelham.

Inclosing corundum, at the asbestos mine.

J. H. Adams, class of '70, Amherst College. Am. Jour. Sci., 2d series, Vol. XLIX, p. 271.

(This is biotite, and is optically negative, with decided biaxial character.)

1876. **Euchlorite** (Shepard). Chester.

Occurs in a layer several inches thick on both sides of an extensive vein of albite (should be oligoclase) 6 to 12 inches thick—"fringe rock." Description given.

Analysis.

SiO ₂	35.51 to 38.46
FeO	15.52
Al ₂ O ₃	6.80
HO	6.10
MgO (dif.)	38.07
	100.00

C. U. Shepard: Contrib. to Min., p. 2 (sep. pub.).

1876. **Ripidolite** (Clinochlore). Pelham.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 4. (Refers to the above citation.)

1876. **Euchlorite** (Shepard). Chester.

Un seul axe négatif comme les biotites. Cette composition étant celle d'un mica magnésien comme la biotite du Vésuve; l'euchlorite de M. Shepard n'est point une espèce particulière, mais une simple variété de mica.

Analysis.

SiO ₂	39.55
FeO	7.80
Al ₂ O ₃	15.95
MgO	22.25
Alkali	10.35
H ₂ O (loss)	4.10
	100.00

M. F. Pisani: Comptes Rendus, Vol. LXXXIII, p. 166.

1876. Biotite.

Great sheets, larger than one's hand, of jet-black shining biotite occur in coarse granitoid portions of the gneiss of the Monson quarry.

1876. Ottrelite. Chesterfield.

A slide of the "spangled mica-schist" is included in the series of slides to illustrate rock-forming minerals, sold by Prof. A. A. Julien and labeled ottrelite.

1887. Biotite. Goshen.

The so-called ottrelite or phyllite of the spangled mica-schist is optically uniaxial, negative, has the brown absorption colors, and all the properties of biotite. It occurs abundantly in the "calciferous mica-schist" (the Conway schists) and in the Devonian schists at Bernardston in small, elongate crystals set transversely to the foliation, as a result of later pressure. It shows abundant gliding planes from pressure, and is inelastic only when weathered. It is loaded with coaly matter and other impurities in the center and is free from inclusions in the outer portion.

1891. Biotite. Buckland.

In fine, large crystals in coarse granite south of Harris's soapstone quarry.

1892. Biotite. Pelham.

The wide fringe of deep bronze-colored biotite in aggregated scales surrounding the mass of olivine rock at the asbestos mine is discussed in the monograph on the area.

1892. Phyllite (under Ottrelite). "Goshen, Chesterfield, Plainfield, etc."

The mica of the spangled mica-schist is still retained in this relation, and reference is made to the fact that Wolff has found a similar mica in the Hoosac schists to be in part ilmenite.

E. S. Dana: A System of Mineralogy, p. 642.

1895. Biotite. Goshen.

The following analysis was made on material carefully selected by me from a typical specimen of the "spangled mica-schist" from the northern part of Goshen. The analysis was made in the laboratory of the Survey by Mr. George Steiger. The water determination was made by Dr. Arthur J. Hopkins, of Amherst College.

SiO ₂	36.96
TiO ₂	.91
Al ₂ O ₃	21.15
Fe ₂ O ₃	2.80
FeO.....	*15.54
CaO.....	.23
MgO.....	7.87
K ₂ O.....	7.47
Na ₂ O.....	1.00
H ₂ O.....	2.93
	96.86

* Determination unsatisfactory, owing to the large amount of insoluble residue.

BITUMINOUS COAL.

1835. **Bituminous coal.** Sunderland, South Hadley, West Springfield.

In coarse, gray, micaceous sandstone and in bituminous shale and "marlite." The question of finding coal in workable quantity is discussed at length.

E. Hitchcock: Geol. Mass., pp. 43, 227.

1841. **Bituminous coal.** Sunderland, at Whitmores Ferry. In the north part of South Hadley.

On the north bank of the Westfield River, in West Springfield, at "Mitneag" (now Mitaneague) Falls. It occurs in the form of small and irregular veins, the coal also being filled with numerous thin veins and crystallizations of calcareous spar.

Analysis.

Volatile matter (water and bitumen)	22.00
Carbon	77.97
Earthy residuum	0.03
	100.00

E. Hitchcock: Geol. Mass., p. 138.

BORNITE.

1823. **Variegated pyritous copper.** Montague.

Sparingly disseminated in calcareous spar in sandstone of the coal formation. Island at Turners Falls.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 231.

1825. **Purple copper.** Chesterfield.

With green feldspar.

C. U. Shepard: Min. Loc.; Am. Jour. Sci., 1st series, Vol. IX, p. 48.

1841. **Variegated copper ore.** Chesterfield.

Is said to have been found in the Chesterfield granite.

E. Hitchcock: Geol. Mass., p. 704.

1891. **Bornite.** Charlemont.

Back of S. G. Turner's house in chlorite-schist, disseminated in grains as large as a pea. (Hawley.)

Near C. Colby's house. Large grains, an inch across, surrounded by malachite. One specimen in cubes. In quartz veins in chlorite-schist. A pit has been dug, and the ore is said to assay \$6 per ton gold, \$2.50 silver.

BREUNNERITE.

1844. **Breunnerite.** See Dolomite.

BROOKITE.

1865. **Brookite.** Chester.

"Rarely attends diaspore and corundophyllite."

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, p. 123.

1865. **Brookite.** Chester.

A few crystals with diaspore.

C. U. Shepard: Report of Chester Emery Mine, p. 12.

1866. **Rutile**, or **Brookite**.

With diaspore. "Professor Shepard thinks he has sufficient evidence to pronounce it brookite."

J. L. Smith: Am. Jour. Sci., 2d series, Vol. XLII, p. 92.

1894. **Brookite**.

I have examined the best collections of Chester minerals, but have never seen brookite among them. The crystals studied by Shepard were destroyed in the burning of his collection at Amherst.

CALCITE.

1810. **Carbonate of lime**. Southampton lead mine.

B. Silliman: Bruce's Min. Mag., Vol. I, p. 64.

1818. **Carbonate of lime**. Southampton lead mine.

Yellowish crystals.

A. Eaton: Southampton adit; Am. Jour. Sci., 1st series, Vol. I, p. 137.

1818. **Laminated calcareous spar**. Deerfield, east of academy.

E. Hitchcock: Geol. Deerfield., *ibid.*, Vol. I, p. 115.

1823. **Calcareous spar**. Chester.

Beautifully crystallized (Emmons).

J. Porter: Min. Loc., *ibid.*, Vol. VI, p. 246.

1823. **Calcareous spar**. Southampton.

"A dodecahedron (hog-toothed spar). A short six-sided prism terminated by three-sided pyramid; same prism with all solid angles truncated."

Deerfield and Greenfield, in greenstone; Leyden and Conway, rhombs in coarse limestone.

E. Hitchcock: Geol. Conn., *ibid.*, p. 211.

1823. **Satin spar**.

"In bituminous shale with ichthyolites at Sunderland."

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 236.

1823. **Argentine**. Southampton lead mine.

"Undulated, not parallel laminae, of a pearly shining luster, often of a beautiful silvery white. Sometimes it is in thin plates which intersect and form small cells, containing crystals of calcareous spar. It occurs on very compact granite, and is also associated with fetid quartz. Is pure CaOCO_2 ."

Analysis.

CO_2	41.00
CaO	54.00
SiO_2	3.25
MgO, FeO	.75
	99.00

Professor Dewey: *Ibid.*, p. 333.

1824. **Carbonate of lime**. Chester.

With chabasie and stilbite, 1 mile east of meetinghouse.

Six-sided tables, flat tables, six-sided prisms.

E. Emmons: Min. Loc., Am. Jour. Sci., 1st series, Vol. VII, p. 255.

1824. Argentine. Southampton.

The argentine from the Southampton mine occurs also grayish; it is beautifully phosphorescent on hot iron; the light a bright and strong yellow.

The mineral has been found in abundance at Williamsburg in considerable masses. Of a beautiful pearly luster and laminated.

Professor Dewey: Additional notices of argentine, *ibid.*, p. 248.

1824. Calcite. Chester.

Crystals in mica-slate, six-sided, table truncated in all its angles, terminated by planes; lenticular from deep truncation of above six-sided prisms and six-sided pyramid. Hexahedral prism so truncated in alternate planes of extremities as to form pentagonal sides terminated by three pentagonal faces. Granular, highly crystalline. In layers in mica-schist. (Emmons.)

C. Dewey: Geol. Berkshire County; *Am. Jour. Sci.*, 1st series, Vol. VIII, p. 32.

1824. Fibrous limestone. West Springfield.

Fibrous in fine red sandstone.

E. Emmons: *Ibid.*, p. 34.

1824. Argentine.

That at Williamsburg decrepitates.

C. Dewey: Geol. Berkshire, *ibid.*, p. 34.

1825. Fibrous limestone (satin spar). West Springfield.

Falls of Agawam River, forming perpendicular veins one-fourth to one-half inch thick in red sandstone slate. Calcareous spar in veins in greenstone, and sometimes embedded in amethyst.

Emerson Davis: *Min. Not.*; *ibid.*, Vol. IX, p. 252.

1825. Pisolite(?). In large quantity on Chicopee River, Springfield.

Robinson's Cat., p. 71.

1825. Argentine. Williamsburg.

"We have recently discovered the locality of argentine. It occurs in large masses of a superior quality. I think some pure masses will weigh tons."

Letter of Mr. Morris Dwight: *Am. Jour. Sci.*, 1st series, Vol. IX, p. 176.

1827. Argentine. Northampton.

Northwest corner of Northampton, passing into Williamsburg, near galena vein. With calcite and fluor pseudomorphs.

A. Nash: Lead mines of Hampshire County, *ibid.*, Vol. XII, p. 257.

1835. Argentine. Westhampton (northeast part, not Williamsburg).

Attached to south end of mass of granite are fragments of mica-slate and micaceous limestone much contorted. Part of latter changed into argentine by the action of the granite.

E. Hitchcock: Geol. Mass., p. 307.

1835. Fibrous limestone.

In new red sandstone. Fibrous, up to 1 inch thick, in shale on Westfield River in West Springfield, and at Sunderland. Stalactites at Sunderland Cave, on east of Mount Toby, several inches thick.

Ibid., p. 231.

1835. Carbonate of lime. Southampton lead mine.

In distinct crystals; a dodecahedron composed of two six-sided pyramids; a short six-sided prism acuminate by three faces; also some with solid angles of prism truncated; delicate straw-yellow.

Ibid., p. 502.

1844. **Calcareous spar.** (*Calciaulus rhombohedrus.*) (Argentine.) Williamsburg, Southampton.

J. D. Dana: Sys. Min., p. 246.

1882. **Calcite.** Deerfield.

Of the minerals which succeed to the prehnite, calcite and datolite are the most important and most abundant, and generally replace each other in different veins. In some a large development of calcite occurs with much axinite; in others an equally large development of datolite.

Excepting quartz, all the minerals enumerated above as inclosures in prehnite occur as inclosures in the calcite which follows it, and when pieces where the latter is abundantly developed are thrown in acid and the calcite nearly dissolved away, specimens of great beauty are obtained, the delicate frostwork of phenite, chalcopyrite, epidote, and the black stout axinites being set off against the brilliant luster of the etched calcite, the whole being sprinkled over with minute pale-green dodecahedra of fluor. It occurs abundantly in distinct crystals and drusy surfaces over the prehnite; — $\frac{5}{4}$ R small with rounded edges; 1^5 bristling over large surfaces; R^5 , OR, $4 R \propto R$, R^3 , with curved and striated faces; R^{12} with deeply striated faces and often distorted; R^7 , — $\frac{1}{2} R^5$ the first striated parallel to — $\frac{1}{2} R$, and the former either acuminate or truncated by a single face of R. Other delicately suspended forms had at one end a single broad face of R and rose in a group of sharp scalenohedra at the other end. Everywhere the crystals were small and affected the most elongate forms with rounded edges and rounded, striated, and distorted faces, as if to imitate as closely as possible the prehnite with which they were associated, while on the datolite the forms $2 R$ or $-2 R$, R invariably appear in large perfectly transparent crystals up to 18 mm. in length, and with a luster equal to that of the datolite itself.

B. K. Emerson: The Deerfield dike and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 352.

1882. **Calcite.** Northampton.

Half a mile below Smith's Ferry, in trap tuff.

Large cavities filled with a fine white crystallization in scalenohedra (R^3 , R) 15 mm. long.

The same forms occur also in Delaney's quarry farther south, near the north line of Holyoke.

1886. **Argentine.** Northampton.

In granite on road from Leeds to Haydenville.

1886. **Argentine.** Northampton, at quarry south of W. N. Moore's, east of Florence.

Quartz pseudomorph after argentine.

1887. **Calcite.** Southampton lead mine.

On quartz; R^3 and R, R^3 , with rounded faces; wine-colored crystals 12 mm. long. Also in large white opaque cleavage faces.

Hatfield lead mine R^3 twinned on O. Three-fourths inch long, opaque white, R with edges beveled by R^3 1 inch across. Is the oldest mineral in the vein at both mines.

1889. **Calcite.** Bardwells Ferry.

West side of river in cut of canal railroad. South side of river, 150 rods west of Bardwells Station.

R^3 , twinned, parallel to O, 1 inch long.

1889. Calcite after salt. West Springfield.

In black, shaly sandstone above dam on the Westfield River, west of the town.

Hopper-shaped cubes of salt, one-half to three-fourths of an inch across, which had been enveloped in the black shale, have been replaced by fine-grained white calcite, and show on surface in white crosses, squares, and triangles. Have been called chiasolite, octahedrite, and spinel.

Specimen kindly given by Mr. J. S. Diller. The full history of this interesting pseudomorph is given under Salt.

1890. Calcite. Loudville, Southampton, lead mine.

Now altered into limonite; ∞ P, — $\frac{1}{2}$ R; 5 mm. long. On quartz.

1890 Satin spar. Chicopee.

Fine, fibrous calcite, in broad veins, in new red sandstone, below dam near mouth of Chicopee River.

Analysis by C. L. Upton, class of 1891, Amherst College:

CO ₂	42.26
CaO	53.59
Fe ₂ O ₃	1.30
MgO.....	1.25
Insoluble	1.15
	99.55
Sp. gr.....	2.73

1890. Concretions.

Irregular concretions, septaria, occur in abundance in the upper shales of the Trias about Springfield and Chicopee.

Very regular and varied forms occur abundantly in the Champlain clays, especially in the banks of the river in Hadley and Montague.

1891. Calcite. Chester. Emery mine.

Form R; also same twinned parallel to — $\frac{1}{2}$ R on magnetite.

1891. Tufaceous incrustation from tube of artesian well at South Hadley.

Analysis by C. L. Upton:

CO ₂	38.21
CaO	46.79
MgO.....	5.46
Fe ₂ O ₃	.80
Insoluble	5.51
	96.77

CASSITERITE.**1825. Pyramidal tin ore.** Chesterfield.

Mohs. Min., Vol. II, p. 387. Haldinger's ed., Edinburgh.

1829. Oxide of tin. Goshen.

At the tourmaline locality a single hemitropic octahedron weighing about 50 grains.

E. Hitchcock: Tin in Massachusetts; Am. Jour. Sci., 1st series Vol. XVI, p. 188.

1832. **Tin.** Goshen.

"I am able to say with perfect confidence that this interesting mineral exists in Massachusetts, but can add little more. I found only a single crystal of its oxide, weighing 50 grains. But this I myself dug from a block of granite in the northeast [northwest] part of Goshen, and on reducing it to metallic tin it corresponds in every respect with that metal from England. I have never been able to find any more specimens."

E. Hitchcock: Geol. Mass.; Am. Jour. Sci., 1st series, Vol. XXII, p. 62.

1835. **Oxide of tin.** Goshen.

"The single crystal was an octahedron with square base, though the measurement of several angles did not agree with those given in the books."

E. Hitchcock: Geol. Mass., p. 509.

1841. **Oxide of tin.** Goshen, northwest part.

"In the sixteenth volume of the American Journal of Science I have given a particular account of the single crystal of oxide of tin which I found several years ago at the well-known locality of several interesting minerals in the northwestern part of Goshen; octahedron with square base. It occurs also in the granite of Chesterfield."

E. Hitchcock: Geol. Mass., p. 706.

1843. **Oxide of tin.** Chesterfield.

Stated to exist in Chesterfield (in Haldinger's edition of Mohs) in "small groups of black twin crystals," and in Dana's description. An analysis (by Hayes) here first given: Crystals $P, \infty P \infty$ —no twins.

J. E. Teschemacher: Description of the oxyde of tin at the tourmaline locality, Chesterfield; Trans. Assoc. Am. Geol., Vol. I, p. 296.

1862. **Cassiterite.**

Now frequently found in the granite of the adjoining towns of Goshen and Norwich (Huntington).

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XXXVII, p. 407.

1882. **Cassiterite.**

I have seen very fine crystals from Chesterfield (25 mm. long, wedged in interstices of tourmaline) in W. E. Webster's collection at Northfield, and fine specimens are preserved in the Shepard collection in Amherst College.

CELESTITE.

1835. **Sulphate of strontia.** West Springfield.

Radiated, on fetid Triassic limestone in West Springfield. Sp. gr. 4. In blowpipe test melts and tinges flame red.

E. Hitchcock: Geol. Mass., p. 232.

1858. **Celestine.** Holyoke. Meacham's quarry.

In Triassic sandstone.

E. Hitchcock: Catalogue of State Museum in Rep. of State Board of Agriculture, App., part xx, No. 107.

CERUSSITE.

1823. **Carbonate of lead.** In cavities of the matrix of the lead mine at Southampton.

White, mixed with yellow; decrepitates and yields lead. It occurs crystallized as follows: Two six-sided pyramids, united at their bases and deeply truncated at their apices, 14 faces; six-sided prism, terminated by four-sided pyramids, 2 of the faces enlarged, 14 faces; tabular prisms with bevelment on the edges. These tables frequently cross each other.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 234.

1825. Carbonate of lead. Loudville mine, Southampton.

Crystallized in right rhombic prisms; green carbonaceous from infiltrated malachite. Earthy, carbonaceous, reddish-brown, massive, and disseminated.

C. U. Shepard: Min. Loc.; *ibid.*, Vol. IX, p. 249.

1835. Carbonate of lead. Southampton.

E. Hitchcock: Geol. Mass., p. 507.

1841. Carbonate of lead. Southampton.

E. Hitchcock: Geol. Mass., Final Rep., p. 705.

1885. Cerussite. Manhan lead mine, Loudville.

A cavity in quartz 5 cm. across, formerly filled by calcite—the quartz having penetrated the cleavage of the calcite on enveloping it—is lined by fine crystals 5 mm. long, which strikingly resemble quartz crystals in the development of their faces; they have adamantine luster, translucent, and are pale topaz color; on them rest two larger crystals of a later generation, 23mm. long, exteriorly colored like the others, interiorly flesh colored, verging on pink. Also beautiful six-rayed penetration twins occur, as in fig. 599 of Dana's Treatise on Mineralogy.

The smaller crystals mentioned above have the form $P, \infty P, 0 P$, penetration twins of two individuals; the larger $\infty P \infty, \frac{1}{2} P \infty, P, \infty P \frac{1}{3}$; the domes horizontally striated and curving into each other.

The specimen is in the Clark collection of Smith College.

1892. Cerussite. Leverett, Hatfield.

Occurs rarely in the baryta veins on quartz and galena, forms $P (111)$, $2 P \infty (021)$, and stellate twins.

CHABASITE.

1818. Chabasie. Deerfield.

Considerably abundant crystals up to one-fourth inch occur in veins of greenstone, both in geodes, on balls of zeolite, on chalcedony, and on lamellar quartz.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. Chabasie. In cuboidal crystals at Chester (Emmons).

J. Porter: Loc. Min., *ibid.*, Vol. VI, p. 248.

1823. Chabasie. Deerfield.

"Hundreds of specimens have been obtained at this place. To procure them, however, requires much labor."

E. Hitchcock: Geol. Conn. River, *ibid.*, Vol. VI, p. 224.

1824. Chabasie. Chester.

Cuboidal crystals one-fourth inch across. Straw-yellow and white; fissures and veins in mica slate 1 mile east of meetinghouse in Chester.

E. Emmons: Min. Loc., *ibid.*, Vol. VII, p. 254.

1844. Chabazite. (*Chabazius rhombohedrus.*) Chester.

J. D. Dana: Sys. Min., p. 340.

1882. Chabazite. Middlefield.

On arenaceous, black mica-schist; coating surface with wine-yellow rhombohedrons one-eighth inch across.

1882. Chabasite. (**Haydenite.**) Chester.

Crystals all simple, beautifully striated and aggregated, intergrown with stilbite on dark-gray mica-schist, three-sixteenths of an inch across. The finest specimens were destroyed in the burning of the Shepard collection.

1882. Chabazite. Cheapside, Deerfield.

At Cheapside it occurs in small, pellucid rhombohedra with delicately striated faces. Crystals 1 mm. in length. It rests always upon the trap, and never upon the heulandite with which it is associated, though when they come in contact the latter penetrates the chabazite and is the older mineral.

Farther southeast of Old Deerfield it occurs in the same association. Most of the specimens agree in all respects with those already described, but are whitened and opaque from incipient decomposition. Rarely much larger crystals occur, which are 6 to 8 mm. in length. These are quite fresh, the faces of good luster, but faceted in a very intricate manner, indicating that the twinning by which the apparent rhombohedra are built up has reached here an unusual complexity. The crystals are commonly twinned on 0, and in three cases very perfect twins, composition face R, occur, both halves being developed to perfect rhombohedra. In a single instance the apex of a crystal is replaced by three large, deeply striated faces of a flatter rhombohedron, apparently $\frac{1}{2}$ R. The striæ run parallel to the combination edge of R and $\frac{1}{2}$ R, and are plainly formed by the oscillatory combination of $\frac{1}{2}$ R and 0. The character of the face did not allow accurate measurement. In thin fissures it incrusts broad areas, producing a tessellated surface made up of a great number of flattened crystals showing each a single face of R, the adjacent ones being in twin position and the whole reflecting the light together like a single face of a very large crystal.

B. K. Emerson: The Deerfield dyke and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 359.

1887. Chabazite. Monson. Flint's quarry, north end.

On horizontal joint surfaces on hornblendic gneiss bands in the biotite gneiss; broad surfaces of minute, aggregated, colorless rhombohedra, 1 mm. across, followed by stilbite.

1890. Chabazite. Greenfield.

Occurs in small colorless rhombohedra at the quarry opened in the west bluff of the trap for road material. It is just below the lookout on the crest of the range.

1891. Chabazite. West Northfield. Wood road west of E. L. Holton's.

On fissures of Bernardston (Devonian) mica-schist. Broad, thin squares one-half inch across, formed by the development of rhombohedra in a narrow space; striated; buff color from decomposition.

1891. Chabazite. Buckland.

In large, colorless rhombohedra in fissures in biotite gneiss, at the quarry on the railroad near Shelburne Falls.

1892. Chabazite. Chester. In amygdaloid.

E. S. Dana: Sys. Min., p. 592. Should be "in mica-schist."

CHALCOCITE.

1887. Chalcocite. Southampton lead mine.

In large masses; rare; surrounding chalcopyrite in layers 8 to 10 mm. thick, and itself surrounded by chrysocolla.

1888. Harrisite. Manhan lead mine, Loudville.

In thick black coating, having when thin a blue tarnish, on galena.

Both the above in the Clark collection in Smith College.

CHALCOPYRITE.

1810. **Copper pyrites.** Loudville.

B. Silliman: Bruce's Jour., Vol. I, p. 68.

1818. **Copper pyrites.** Greenfield. Banks of Connecticut River.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 115.

1823. **Pyritous copper.** Southampton, Leverett, Deerfield, Greenfield.

"At Leverett lead mine, amorphous. At Deerfield and Greenfield, in veins in greenstone and sandstone.

"At Southampton lead mine, where it occurs amorphous and crystallized in regular tetrahedrons, which are insulated on calcareous spar. For the specimens containing these crystals I am indebted to Dr. David Hunt."

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 231.

1826. **Pyritous copper.** Westfield.

"In bituminous marlite."

E. Davis: Rocks and minerals of Westfield, *ibid.*, Vol. X, p. 215.

1832. **Pyritous copper.** Montague. On southern island at Turners Falls.

Rich, and in considerable quantity.

E. Hitchcock: Geol. Mass., p. 62; also Am. Jour. Sci., 1st series, Vol. XXII, p. 61.

1832. **Pyritous copper.** Leverett, Southampton.

E. Hitchcock: Geol. Mass., p. 507.

1838. **Sulphuret of copper.** Russell, farm of J. Gould.

In vein with blende and galena.

E. Hitchcock: Econ. Geol. Mass., p. 127.

1841. **Pyritous copper.** Greenfield.

"One vein on bank of Connecticut River, 100 rods below mouth of Fall River, the other a mile lower down; both several feet wide; in trap and sandstone; gangue, sulph-baryta and toadstone; green carbonaceous and pyritous copper.

On the south island at Turners Falls a vein of pyritous copper of rich quality and in considerable quantity. Indeed, several varieties of the sandstone rocks there seem to be impregnated with copper."

E. Hitchcock: Geol. Mass., p. 203.

1865. **Chalcopyrite.** Chester emery mine.

Few grains in margarite; upon joints of gneiss near the vein, with malachite.

C. U. Shepard: Report Chester emery mine, p. 12.

1882. **Chalcopyrite.** Greenfield, Cheapside, Gill.

Occurs disseminated in particles in the trap, in the prehnite, and in the calcite above (the latter rarely in tetrahedra up to 2 mm. in length), in cavities in the prehnite, and in minute, fresh-looking striated tetrahedra in calcite. Also on botryoidal diabantite and in the "chlorophæite" in Gill.

B. K. Emerson: Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 350.

1883. **Chalcopyrite.** Turners Falls. Island in river.

There was a very fine rich specimen in the Shepard collection, destroyed by fire in 1883.

1888. **Chalcopyrite.** Davis, Rowe.

Shipped as an ore from the Davis mine, disseminated in pyrite. Min. Resources of U. S. for 1887, p. 742.

CHIASTOLITE.

See Andalusite.

CHLORITE.

See Prochlorite.

CHLORITOID.

1865. **Masonite** (the variety near to ottrelite). Chester.

Is abundant at many places in the emery vein on the North Mountain.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, p. 123.

1865. **Ottrelite** (masonite, chloritoid). Chester emery mine.

Belongs to the same group as margarite. In disseminated scales of a dark, blackish-green color, whose breadth is rarely more than one-fourth of an inch. They present considerable resemblance to mica, but when seen on weathered surfaces of the veins or on open joints of the rock are easily distinguished by their greater hardness and want of elasticity. It is chiefly confined to the stony emery, i. e., the chloritoidal rock or substance of the vein. Over 20 per cent FeO, 6 per cent H₂O. It stands in relation to mica somewhat as emery does to corundum.

C. U. Shepard: Report Chester emery mine, p. 10.

1876. **Chloritoidite**. Chester.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 4.

The biotite in transverse plates in the spangled mica-schist has often been called ottrelite (phyllite, Thomson, in Dana's Mineralogy). See citations under Biotite.

CHLOROPHÆITE.

1825. **Chlorophæite**. (J. W. Webster.)

Additions to the cabinet of minerals at Cambridge presented by Rev. Mr. Hitchcock; greenstone containing rounded nodules of a dark-green color, which on examination I find to be chlorophæite.

J. W. W.: Bost. Jour. Phil., Vol. III, p. 610.

1826. **Chlorophæite**. Turner's Falls, Gill.

"Trap rocks about Turner's Falls, in Gill. (Determined by J. W. Webster.) Is in radiating masses, pea to bullet size, several frequently united. Sometimes cavities partly filled with calcite. Newly broken yellowish-green or dark bottle-green, sometimes semitransparent; darkens on exposure; this is obvious in one-half hour in sunlight; in a few hours is nearly black, and then radiated structure becomes less and less distinct and in some black specimens is scarcely to be discerned; at surface all nodules are changed to black, dark-green, or the dull muddy-green of steatite, and the same an inch or more into the rock. Some specimens are of dark-cinnamon color, others long exposed become covered with a rusty powder; it is so soft as easily to be scratched by the finger nail. Occurs 80 rods below the falls on the north side, and 20 to 30 rods above the mouth of Fall River. To be distinguished from chlorite (delessite), which is in folia. The chlorophæite is in minute acicular needles."

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. X, p. 393.

1835. **Chlorophæite**.

"It appears to be decomposed mesotype."

C. U. Shepard: Min., 1st ed., Vol. II, p. 125.

1841. Chlorophæite. Gill.

"This mineral when the rock is first broken is of a dull-green color, but after a few hours' exposure it becomes nearly black; after long exposure, however, some specimens assume a dark-brown color. For the most part, the nodules—often half an inch and sometimes more than an inch in diameter—exhibit a fibrous structure, the fibers radiating from one or more centers in the same nodule. The mineral is easily scratched with a knife, and the powder is of a dull-green color. When fractured, however, it appears brittle, and sometimes calcareous spar is inclosed in the chlorophæite, but very rarely are the nodules hollow. If I mistake not, in one or two instances I have observed a foliated structure in the specimens; associated with prehnite, chlorite, and pyritous copper; the rock only slightly amygdaloidal."

E. Hitchcock: Geol. Mass., p. 660.

1852. Chlorophæite.

Stands in close connection with chlorite or green earth.

C. U. Shepard: Min., 3d ed., p. 151.

1878. Chlorophæite. "Gill, in Massachusetts, and Turners Falls, in Connecticut."

P. Groth: Min. Col., Strasburg, p. 258.

(Turner's Falls is in Gill.)

1882. Products of the decomposition of prehnite (chlorophæite of Hitchcock).

The mineral chlorophæite, described by Macculloch in 1825, but not analyzed, proves now, from the analysis of Heddle,¹ to be of very different composition from the highly hydrated protoxide of iron silicate analyzed by Forchhammer, with which it has been associated. It is a magnesian peroxide of iron silicate, with about 25 per cent of water, sometimes aluminous, and it approaches thus more nearly to diabantite, from which it differs mainly in the peroxidation of the iron and in containing double the quantity of water.

In 1825 President Hitchcock discovered a mineral "in the trap rocks about Turners Falls, in Gill, Mass.,² which Prof. J. W. Webster, of Harvard University, pronounced to be the chlorophæite of Macculloch." The description given by President Hitchcock agrees so exactly with that of Macculloch and Heddle, and the rapid blackening of the mineral is so peculiar, that the reference was very natural, and I think correct.

On examining slides of the "smoked" prehnite³ last described, its radiated needles were in the center colorless and perfectly fresh, and contain in abundance scales of diabantite, with remarkably strong dichroism brown-green to black. Although the smoky, black mass resembled closely an amygdale of the chlorophæite, its great hardness and the crystalline surface proved it to be prehnite, and the peculiar striation dependent upon the arrowhead twinning was quite as characteristic. Toward the outer surface, however, the mass softened rapidly and could be readily impressed by the finger nail, and under the microscope the fibers were seen to change quite rapidly into an amorphous or fine, scaly material of red-brown color, showing faint aggregate polarization, but no dichroism. Farther in among the clear needles portions of the mass have all the needles likewise stained brown superficially. On examining President Hitchcock's original speci-

¹Trans. Royal Soc. Edinburgh, Vol. XXIX, p. 84.

²Am. Jour. Sci., 1st series, Vol. X, p. 393.

³See Prehnite.

1882. Products of the decomposition of prehnite—Continued.

men, No. 91 of the last catalogue of the Massachusetts State collection,¹ it was found to be distinctly radiated from several centers, the fibres of the same size and arrangement as those of the fine fibrous prehnite, and a fragment broken from the specimen gave a pale-green powder and scratched apatite without difficulty. The cavity in which it is found is lined first with the foliated diabantite, then follows inwardly chalcopyrite, chlorophæite, the latter occupying thus the same place as the prehnite in the unaltered nodules.

Under the microscope traces of the bright quartz-like polarization and the peculiar striation of prehnite could be clearly seen. The latter mineral was, however, for the most part changed into a red-brown, indistinctly scaly mass, with very faint polarization. The fibers of the original prehnite had not been at all fused together or changed in their relation to each other, and nothing was interposed among them. Other nodules completely changed showed also the network of black material between the needles. In specimen No. 92 of the same collection with H. 1.5, the fibrous structure is much less distinct than in the former one; both are of the same dull, black color, but under the microscope it is seen to be made up of the same faintly scaly red-brown material arranged in radiated needles exactly as before, but now showing no trace of the further presence of unchanged prehnite. The brown material is not to be distinguished under the microscope from that which results from the change of diabantite, except that in each case the structure of the original mineral is retained.

In other cases the change of the prehnite has taken another course. In the variety from the new cutting at Cheapside, where the lustrous bars of the mineral are interwoven with minute green fluor, the bars change toward the side where the fissure in which they were formed opened into the main vein, gradually into a pale-green scaly mass which retains for a distance the shape of the bars and their relation to the fluor, but farther on is blended into a pale-green mass with satiny luster, which looks as if it had been worked up into a paste and dried in a thin layer upon the surface. Similar masses are found abundantly, especially in the datolite, and under the microscope still contain fragments of fresh unchanged prehnite.

The mineral itself is under the microscope seen to be made up of loosely aggregated scales and to show a bright green color and a dichroism, both like that of diabantite. It is apparently hexagonal, many scales remaining black during a complete revolution between nicols. Its lighter color seems to be the result of its different aggregation, and the powder of both is of the same light green. Prehnite can thus change into a mineral very similar to, if not identical with, diabantite (enough pure material for an analysis could not be obtained), and both the prehnite and the common scaly radiated diabantite change into red-brown almost amorphous materials which can not be distinguished microscopically.

I have assumed, on what seems good grounds, that the diabantite which fills the fibrous prehnite so often was formed at the same time with the latter, and it often shows a zonal arrangement in the prehnite which goes far to show that this was so, and in the specimens the two cases² can be easily distinguished. On the other hand, I think the change of the prehnite is primarily into the green diabantite-like mineral and through

¹State Board of Agricult. Report, Vol. VI, Appendix, p. 16, where the mineral is printed "Chlorophocite."

²That of the diabantite originally inclosed in the fresh prehnite and the similar scaly mineral formed by the decomposition of the latter.

1882. **Products of the decomposition of prehnite—Continued.**

this into the brown peroxidized substance, and that the instability of the first or protoxide stadium of the substance is the condition of its rapid change from green to brown or black when exposed to the air. Indeed, this is also a striking characteristic of the common diabantite itself, and fresh trap specimens lose their green tint and soon turn brownish-black if exposed to the weather, though the change does not occur with such remarkable rapidity as in the case with the prehnite-diabantite, or chlorophæite. Professor Heddle explains the sudden change of color by shrinkage-cracking, due to partial dehydration.

B. K. Emerson: The Deerfield dike and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 276.

CHONDRODITE.1884. **Chondrodite.** Middlefield.

Occurs in the pre-Cambrian limestone at the mouth of Coles Brook, at the railroad cutting, west edge of large bed, in reddish and grayish grains changing into serpentine. It can also be found at various places in the band of limestone which extends from this point north to the school at Factory Hollow.

CHROMITE.1820. **Chromate of iron.** Cummington.

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. II, p. 374.

1823. **Chromate of iron.** At Cummington soapstone quarry.

Only a small mass has as yet been discovered.

J. Porter: Min. Not., *ibid.*, Vol. VI, p. 248. There is no soapstone quarry in Cummington. The quarry in Windsor, cited below, which is near the Cummington line, must have been meant.

1823. **Chromate of iron.** Cummington, Middlefield in serpentine (Eaton).

Cummington, well characterized and almost resembling the Baltimore chromate; in a loose mass found by Dr. J. Porter.

E. Hitchcock: Geol. Conn. River, *ibid.*, p. 233.

1833. **Chromate of iron.** Cummington. Blandford.

"While the second edition of this work was passing through the press I have discovered the chromate of iron in serpentine in Blandford; specimens 4 to 5 pounds weight."

E. Hitchcock: Geol. Mass., p. 52, 366; also Am. Jour. Sci., 1st series, Vol. XXIV, p. 397.

1835. **Chromate of iron.** In the east part of Windsor, near soapstone quarry, in serpentine.

E. Hitchcock: Geol. Mass., p. 363. Cummington, Blandford, *ibid.*, pp. 52, 369.

1838. **Chromate of iron.** Chester.

Report of Dr. H. Holland. Appears in the eastern portion of the serpentine; three outcrops 5 to 18 inches wide; 1,200 pounds of ore obtained; one mass pure, 60 pounds; trace of platinum. CrO 52-53, FeO 33-35. Salts prepared from it are in the State collection.

E. Hitchcock: Econ. Geol. Mass., p. 124.

1841. **Chromate of iron.** In serpentine, 5 miles northwest of Blandford, on Becket road.

Tuberculous masses rarely as much as a foot in diameter; in masses a few inches in diameter; contains 30 per cent of oxide of chrome (Dr. H. Holland). A few miles north in the west part of Chester, near the railroad, on branch of Westfield River, a much larger vein was discovered by Dr. Holland. It is situated in the eastern portion of the serpentine, perhaps 300 feet above the railroad, where it cuts through the serpentine, and on the same side of the river. Said by practical chemists to afford 43 per cent CrO (Holland).

Analysis (by Dr. Hitchcock).

CrO	34.63
Fe ₂ O ₃	50.65
SiO ₂	9.27
Al ₂ O ₃	5.45
	100.00

E. Hitchcock: Geol. Mass., 1841, pp.191, 618.

1882. **Chromite.** Pelham.

From the serpentine near the asbestos mine. In grains 3 to 5 mm. in diameter.

CHRYSOCOLLA.

1876. **Chrysocollite.** (C. U. Shepard.) Southampton lead mine.

C. U. Shepard: Cat. of Min., within 75 miles of Amherst College, p. 3.

1888. **Chrysocolla.** Manhan lead mine, Southampton.

In layers 5 to 10 mm. thick, coating cuprite and chalcopyrite; rare; finest specimens in Clark collection in Smith College.

CHRY SOLITE.

1876. **Pelhamine.** (C. U. Shepard.) Pelham.

"Singular seams and masses, sometimes a foot thick at the asbestos mine, associated with bronzite and talcite; tough and so not serpentine; lusterless; powder dark greenish-gray; H.=5; Gr.=2.9—3.2. B. B. infusible, but turns cinnamon-red; not decomposed by acids.

Analysis.

SiO ₂	38.40
FeO	15.52
Al ₂ O ₃	2.80
H ₂ O	3.40
MgO (dif.).....	39.88
	100.00

C. U. Shepard: Contrib. to Min., p. 3. (Priv. pub.)

1876. **Pelhamine.** Pelham.

Is allied to chrysolite.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 5.

1881. Olivine. Pelham.

The black, tough masses at the Pelham asbestos quarry called pelhamine by Shepard prove upon microscopical examination to be a colorless chrysolite in intimate mixture with chromite and other oxides. It makes the mass of an immense intrusive neck in the Becket gneiss as the principal ingredient of an olivine rock which contains much magnetite and little bronzite and is separated from the gneiss by a broad band of biotite, anorthite, corundum, and apatite of so much special geological interest that it is described at length in the forthcoming monograph upon the geology of the region.

1883. Olivine. Shutesbury, New Salem.

The so-called serpentine masses in the centers of these two towns are largely olivine, in the same position in the gneiss and with the same associated minerals, in part, as in the Pelham locality. In all these localities the mineral is of so much more lithological than strictly mineralogical interest that I have discussed it under the former head, as indicated above.

1883. Olivine.

A pale olive-green olivine in crystalline grains .5 mm. to 2 mm., superficially reddened by decomposition, in a light-gray amygdaloid boulder in the till on the north slope of Mount Holyoke, just west of the Notch.

1884. Pelhamine. Pelham.

The serpentinous substance called pelhamine by Prof. C. U. Shepard admits of a good polish and with a very curious effect.

Kunz: Precious stones; Min. Res. of the U. S., 1883-84, p. 776. Gems and precious stones, 1890, p. 189.

1885. Olivine. South Hadley.

I have never with certainty detected olivine in the large Holyoke and Deerfield diabase beds, but in the later volcanic necks, especially in that north of Moodys Corners, small brick-red decomposed olivines are quite frequent.

CLINOCHLORE.**1879. Clinochlore. North Blandford.**

In coarse, large, foliated masses at Bartholomew's soapstone quarry, Blandford.

Similar occurrence at Osborne's soapstone quarry. Optically positive. Quite strongly biaxial. Dichroic green and red; weakly so with microscope. Very dark green, in broad plates much cut by gliding planes.

1889. Clinochlore. Chester.

Pseudomorph. Mixture of epidote and clinochlore after hornblende.

In the collection of E. B. Underhill, formerly of Hallocks Mills, Westchester County, N. Y., which was bequeathed to Amherst College, was a specimen labeled "Chloritoid pseudomorph after hornblende, Chester, Mass." This collection was labeled, as he informed me, by Mr. J. S. C. Bailey, who, I believe, largely formed the collection; and as Mr. Bailey has collected extensively in Chester, I presume he obtained the specimen there. It came manifestly from the cutting near the railroad station from the white granular quartzite, containing shining, black hornblende blades, and I have since found it at that place. These are here changed centrally into pale pistachio-green granular epidote and dark-green chlorite having the optical properties of clinochlore. The blades are above an inch long and one-third of an inch wide.

1892. **Clinochlore.** Orange.

Soapstone quarry at southwest corner of Big Tully Mountain. In broad plates of clear green in granular dolomite and impure talc. Optically positive and nearly uniaxial.

COBALTITE.

1820. **Arsenate of cobalt.** Sturbridge, Monson.

Disseminated in small quantities in a large mass of hornblende connected with the graphite of the Sturbridge mine.

In hornblende rock in Monson; in hornblende rock on west side of Connecticut River Dr. Hunt found arsenide of cobalt.

A. Eaton: Index, pp. 118, 139.

1825. **Arsenate of cobalt.** Monson.

In primitive trap in small quantity.

A. Eaton: Index; Robinson's Cat., p. 61.

(No further notice of this mineral. Much whitish pyrite occurs at the Sturbridge mine and in hornblende-schist at the Monson quarry.)

COLOPHONITE.

See Garnet, 1823.

COLUMBITE.

1829. **Stanniferous columbite.** Chesterfield, Goshen.

In a loose stone in the foundation of a stone fence (at a little distance from the south end of the tourmaline ledge), in feldspar, beryl, and mica, 15 to 400 grains in size—1,400 grains in all; sp. gr. 6.00; crystal figured; contains columbic acid, tin, iron, manganese, lime trace.

Also at Goshen, at Weeks's farm, and 4 miles east of first location of spodumene. Small imperfect tabular crystals in spodumene.

C. U. Shepard: Discovery of columbite in Chesterfield, Mass.; Am. Jour. Sci., 1st series, Vol. XVI, p. 220.

1835. **Columbite.** Chesterfield, Goshen.

Chesterfield tourmaline locality. Right rectangular prism, several modifications; two places in Goshen in spodumene. (Shepard.)

E. Hitchcock: Geol. Mass., p. 509.

1835. **Columbite.** Chesterfield.

The columbite of Chesterfield consists of the oxides of columbium, tin, iron, manganese, with trace of lime. More distinct crystals (than from Haddam), and of greater size, come from Chesterfield.

C. U. Shepard: Min., 1st ed., Vol. II, p. 140.

1841. **Columbite.** Chesterfield, Goshen.

At tourmaline locality in Chesterfield, and also at two places in Goshen, embedded in spodumene.

E. Hitchcock: Geol. Mass., p. 704.

1844. **Columbite.** Chesterfield.

Small crystals; brilliant, transparent, dark ruby-red.

J. S. Teschemacher: Bost. Jour. Nat. Hist., Vol. IV, p. 502.

1866. **Columbite.** Northfield.

"Sent me last autumn by Mr. M. A. Brown, of Springfield, Mass.; found on land of Mr. Simeon Lyman, 1 mile northeast of village. In much disintegrated graphic granite in mica-slate; tolerably well crystallized, black and shining; sp. gr. 6.5. Nearly identical with the Bodenmais variety. Supply limited."

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

1876. **Columbite.** Northfield, Chesterfield, Goshen.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 7.

1882. **Columbite.** Northfield.

In granite vein in lane one-half mile east of John Moody's house. Mr. M. A. Brown got \$400 worth. Also with beryls. Best crystals went to Prof. George A. Brush.

Good crystals in W. E. Webster's collection, Northfield. Locality exhausted.

1883. **Columbite.** West Chesterfield Hollow.

Crystals 1 inch long; striated curiously, as if molded when soft.

In W. E. Webster's collection, Northfield.

1886. **Columbite.** Northfield.

Is almost a tantalate, with 57 per cent Ta_2O_5 and 27 per cent Nb_2O_5 , and sp. gr. 6.84. Agrees with the general habit of columbite, as it has the same faces, and—in so far as one can judge from the imperfect measurements—the same angles. The crystals, which are large and rough, show the common rectangular habit with the faces a (100), $\infty \bar{P} \infty$; b (010), $\infty \bar{P} \infty$; c (001), $0 P$; m (110), ∞P ; z (530), $\infty \bar{P} \frac{2}{3}$; k (103), $\frac{1}{2} \bar{P} \infty$; n (163), $2 \bar{P} 6$; $c: k = 20^\circ$; $b: z = 63^\circ$.

E. S. Dana: Ueber den Columbit; Zeit. Krys., Vol. XII, p. 266. Abstract Am. Jour. Sci., 3d series, Vol. XXXII, p. 386.

COOKEITE.

1879. **Cookeite.** Chesterfield, in cleavelandite.

A. A. Julien: Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 351.

1882. **Cookeite.** Chesterfield.

Fine specimen in W. E. Webster's collection, Northfield, Mass.

COPPER.

1823. **Native copper.** Whately.

In geest on the limit between the primitive and alluvial soil, and about 5 miles from the secondary greenstone of the coal formation. The piece weighs 17 ounces, exhibits imperfect rudiments of octahedral crystals on the surface, and is incrustated by green carbonate of copper. The cavities also contain a very little red oxide of copper.

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. VI, p. 230.

1843. **Copper.** Whately.

"The first piece of copper was found along the line of junction between the sandstone and the primary rocks in a plowed field; the second piece 2 miles farther to the west among the hills. I incline to the opinion that neither of these specimens originated in the trap or the sandstone, but in the primary rocks to the north of the places where they were found. They were mostly coated by the green carbonate and the red oxide (?). The last specimen was partially covered also with crystals of quartz deeply implanted. The extremities of these have all been broken off in efforts to cut the specimens into pieces, but their lower extremity may still be seen in the only fragment of this fine specimen which can now be found and which I lay upon the table with the former specimen uninjured."

E. Hitchcock: Ann. N. Y. Acad. Sci., 1843; also Am. Jour. Sci., 1st series, Vol. XLVII, p. 323.

1843. **Copper**—Continued.

The word geest above was used to designate the drift and the diluvial gravels.

Similar bowlders of copper have been found in Connecticut within the limits of the red sandstone, and a fine specimen is preserved in the Yale College cabinet. Those mentioned above doubtless came from the neighborhood of the trap, apparently reduced by it from older copper veins. It is hard to see how the pieces can have been carried south 10° west from the trap in Greenfield to Whately by the ice. Perhaps they had been lost there by the Indians.

The first specimen mentioned above is in the mineral collection of Amherst College. There are several cavities upon the surface from which quite large crystals apparently of calcite have been removed.

A specimen of native copper is in the museum of Amherst College having this label in President Hitchcock's handwriting: "Native copper found in drift 200 rods west of the meetinghouse in Whately, and on the farm of Rufus Dickinson, and presented by him and Dennis Dickinson to the college cabinet. Weight, 2½ pounds."

CORDIERITE.

1835. **Iolite**. Goshen.

"Stated to have been found in Goshen. I have not met with it."

E. Hitchcock: Geol. Mass., p. 507.

Refers to the "goshenite" of Goshen. (See under Beryl.)

1838. **Iolite**. Brimfield.

One-half mile northeast of village on road to Warren, near house of Samuel Patrick. In granite; violet-blue; no crystals; found 1835; with molybdenite, black mica, and garnet.

J. W. Foster: Am. Jour. Sci., 1st series, Vol. XXXIII, p. 399.

(The molybdenite is graphite.)

1844. **Iolite**. (*Hyalus bicolor*.) Brimfield.

J. D. Dana: Sys. Min., p. 406.

1886. **Cordierite**. Brimfield, Sturbridge.

On the west side of the road to Warren, and near the town line, 1 mile north of Elisha Marsh's house. In coarse granite associated with moonstone-like orthoclase, precious garnet, and fibrolite; deep blue to colorless; in granular masses up to the size of a robin's egg. Also found on the top of Shumway Hill, in Sturbridge, by G. H. Haynes, of the class of '87 in Amherst College, in larger darker masses in same rock.

1890. **Iolite**. Brimfield.

In gneiss with andalusite.

Kunz: Gems and precious stones of the United States, p. 159.

(Incorrect; should be "in granite with fibrolite").

1892. **Cordierite**. Ware.

In the first cutting south of the station on the Central Railroad. In deep-blue granular masses. The fibrolite schist is here full of veins and twisted lenses of pegmatite, and the cordierite is contained in these near their borders, and at times rounded blebs of the deep-blue mineral are inclosed in the chatoyant carlsbad twins of orthoclase.

CORUNDOPHYLLITE.

1865. **Chloritoid.** Chester.

C. T. Jackson: Am. Jour. Sci., Vol. XXXIX, p. 87.

1865. **Corundophyllite.** Chester emery mine.

Mineral not fully analyzed. Imperfect examination made upon a few grains of it found along with the sapphire of Buncombe, N. C., lead to the conclusion that it, like the ottrelite, is a silicate of alumina and iron with but little lime and magnesium. Des Cloizeaux has described it as one of the micaceous minerals, but it rather appears to belong to the clinocllore group. Its crystallization is near to mica; $H.=2-3$. Inelastic, almost brittle; in color and in the arrangement of its particles, even when giving rise to a slate, as it often does, it does not resemble the well-known mineral chlorite. It is of all others the most abundant gangue mineral of the purer varieties of both emery and magnetite.

C. U. Shepard: Report Chester emery mine, p. 10.

1865. **Corundophyllite.** Chester.

Abundant; called chloritoid by Dr. Jackson.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, p. 112.

1866. **Corundophyllite.** Chester.

Analysis (given below in 1868) from material supplied by Prof. C. U. Shepard, with description; referred to ferriferous clinocllore (ripidolite).

F. Pisani: Ibid., Vol. XLI, p. 394.

1866. **Corundophyllite.** Chester.

The author obtained the species at Chester and sent a specimen to Professor Shepard, asking if it was his corundophyllite. On being informed that it was he then analyzed the specimen. It proves to be both chemically and physically a chlorite of the variety ripidolite.

Analysis.

SiO ₂	25.06
Al ₂ O ₃	30.70
FeO	16.50
MgO	16.41
H ₂ O	10.62
	99.29

J. L. Smith: Emery mine at Chester, *ibid.*, Vol. XLII, p. 92.

1866. **Chloritoid.** Chester.

An analysis given under the name chloritoid, which is criticised by Dana as incorrect.

C. T. Jackson: Am. Jour. Sci., 2d series, Vol. XLII, p. 107.

1866. **Corundophyllite.** Chester.

In a letter Professor Shepard claims that the true corundophyllite is that from Asheville, N. C. He has, however, published the mineral at Chester as corundophyllite.

J. D. Dana: Ibid., p. 269.

1866. **Corundophyllite.**

Admits the chloritoid of Jackson and the clinocllore of Smith to be clinocllore. The mineral attached to the fringe rock, and analyzed by Professor Smith and found to be biotite, he now claims to be corundophyllite, as it has $H.=1.5$; inelastic; sp. gr. 2.76. Before the blowpipe it hardens, and melts with difficulty.

C. U. Shepard: Ibid., p. 421.

1867. Corundophyllite. Chester.

Is clinocllore, optically.

J. P. Cooke: Some American chlorites; Am. Jour. Sci., 2d series, Vol. XLIV, p. 206.

1867. Corundophyllite.

"Corundophyllite is a clinocllore in plates or crystals; bisectrix positive, inclined."

Des Cloizeaux: Letter to Prof. J. D. Dana; *ibid.*, pp. 258, 283.

1868. Corundophyllite. Chester.

Analysis by Prof. J. H. Eaton. Column No. 1, crystals with diaspore, rutile, and sapphire. No. 3, fringe rock. No. 2 is by Pisani. Professor Shepard states that he supplied the same material for Nos. 1 and 2.

	No. 1.	No. 2.	No. 3.
SiO ₂	24.77	24.0	24.69
Al ₂ O ₃	25.52	25.9	28.52
MgO	21.88	22.7	21.86
FeO	15.19	14.8	16.38
H ₂ O	11.98	11.9	(¹)
	99.34	99.3	-----

¹ Not determined.

C. U. Shepard: *Ibid.*, Vol. XLVI, p. 257.

Analysis No. 3 of the fringe rock is also corundophyllite, with probably a slight error in the Al₂O₃ determination. It is very different from the analysis of the fringe rock, by J. L. Smith, which is given under Biotite, 1866.

1891. Corundophyllite. Chester.

In an elaborate work upon the chlorites, Professor Tschermak describes the mineral fully and determines its optical characteristics. His results are made the basis of the description of the mineral by E. S. Dana in the new edition of the Manual of Mineralogy.

G. Tschermak: Die Chloritgruppe; Sitzungsberichte d. Akad. Wien, XCIX, p. 210.

1894. Corundophyllite. Chester.

The mineral is uniformly the oldest in the veins in magnetite, in which it occurs, and where it is not covered by later growths forms surfaces of hexagonal prisms, tapering by irregular steps from the larger attached end. It is followed by rutile, corundum, anorthite, diaspore, margarite, and calcite. Its growth continues in lessened degree through this series, small crystalline plates being perched upon the corundum blades or wholly inclosed in calcite, where it is followed immediately by margarite; broad sheets of it run up between the laminae of the margarite. Some very beautiful crystals of dark-green color are capped by colorless or pale aquamarine colored heads. The transition is sudden, and the prisms below have colorless centers. The heads have perfect faces, in forms like fig. 7, p. 645, in the new edition of the System of Mineralogy (E. S. Dana), and, like it, are divided into irregular twinned segments. They are almost uniaxial. I can not distinguish these pale-green forms from amesite (q. v.), and I have noted the apparent passage of the one mineral into the other. The material seemed perfectly fresh.

CORUNDUM.

1865. **Emery.** Chester.

First announcement with description and analyses. Considers it a distinct species. $\text{FeO}, \text{Al}_2\text{O}_3$.

C. T. Jackson: Am. Jour. Sci., 2d series, Vol. XXXIX, p. 87.

1865. **Corundum.** Chester.

White massive corundum in veins one-half inch wide occurs traversing massive emery. The latter mineral at Chester is exceedingly uniform in composition and may be regarded as an aluminate of protoxide of iron; $\text{FeO}, \text{Al}_2\text{O}_3$.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, p. 123.

1865. **Corundum.** Chester.

Rare; only in seams one-half to three-fourths inch thick, though many 1 foot square; grayish white, highly crystalline, like that from the Carnatic; in granular and compact emery.

C. U. Shepard: Report of Chester emery mine, p. 9.

1865. **Emery.** Chester.

(a) No perfect crystals; coarsely massive or in large separate individuals up to one-half inch across; perfect cleavage and striæ; reddish-brown with faint coppery luster; 0.5, higher sp. gr. than corundum; abrading power $\frac{1}{2}$; magnetic, $\text{FeO}, \text{Al}_2\text{O}_3$.

(b) Granular, flattened grains one-eighth to one-half inch in corundophyllite; formed from fusing of grains.

(c) Compact, very fine grained, tough, massive, harsh dark-brown, faint violet-blue tarnish in wedge-shaped, contorted masses or elliptical balls 5 to 10 inches across.

(d) Emery magnetite, massive magnetite, containing emery harder and tougher than magnetite, and has purple tarnish.

(e) Stony emery—the general substance of the vein, or the chloritoidal rock—slaty, tough, greenish-gray, very heavy, 10 to 20 per cent emery.

C. U. Shepard: Report Chester emery mine, pp. 6–8.

1865. **Emerite.** Chester.

“And he (Dr. Jackson) has suggested that it be considered a distinct species in place of being included under corundum. (Note.—Should it hereafter be found proper to separate emery from corundum, the name emerite ought not to be an unsuitable designation for the new species.) His conclusion would obviously be acquiesced in were it not for the strong resemblance in striæ and cleavage between the emery and common corundum, making it impossible for us to separate the substances crystallographically from one another. It would, however, be singular if two minerals differing so widely in their other physical qualities should be specifically identical.”

C. U. Shepard: Report Chester emery mine, p. 6.

1866. **Emery.**

Dissents from the opinion of Messrs. Jackson and Shepard that emery is a separate mineral and gives several analyses:

	Poor.	Better.	Prepared.	Crystals.	After HCl and H ₂ O.
Al_2O_3	44.01	50.02	51.92	74.22	84.02
Fe_3O_4	50.21	44.11	42.28	19.31	9.63
SiO_2	31.30	3.25	5.46	5.48	4.81

H. Lawrence Smith: Am. Jour. Sci., 2d series, Vol. XLII, p. 83.

1866. Sapphire. Chester.

In dolomite veins, at Chester emery mine.

C. T. Jackson: Proc. Bost. Soc. Nat. Hist., Vol. XVI, p. 32.

1868. Corundum. Chester.

Occasionally in blue bipyramidal crystals.

J. D. Dana: Sys. Min., p. 139.

1870. Corundum. Pelham.

Nodules of brownish-black mica superior in hardness to the surrounding mineral contain nodules of corundophyllite, which inclose a white corundum often streaked with a deep sapphire-blue; rare

J. H. Adams, October, 1870: Am. Jour. Sci., 2d series, Vol. XLIX, p. 271.

(The "corundophyllite" is biotite.)

1881. Emery and iron. West Worthington.

"Abram Granger's 50-acre pasture lot. Local geology," No. 2.

Chauncey Stephenson: Hampshire Gazette, November 29, 1881.

(The writer sent me some hornblende-schist as a sample of the emery.)

1885. Emery. Chester.

In veins in the magnetite showing the paragenesis—magnetite, corundophyllite, rutile, corundum, diaspore, calcite. The corundum occurs in flat blades partly white, partly deep blue, or rarely pink, which appear on dissolving the calcite and which at times are attenuated to blue threads running up into the calcite after the manner of graphic granite. The plates polarize in bright color and are very flat, distorted rhombohedra.

1886. Corundum. Hampden mine.

Report for 1880: Capital, real and personal, \$310,000; total hands employed, 31 (1 boy, 11 men below ground); amount of wages, \$9,347; boiler, 1; engine, 1; horsepower, 10; drainage machines, 2; hoisting machine, 1; fuel, cords of wood, 365; explosives, cost, \$254; value of all materials, \$4,572; product, tons, 600; value, \$18,000.

Tenth Census, Vol. XV, 1886, p. 840.

1886. Corundum. Chester.

The finest piece of deep-blue massive corundum from the Chester mine is in the collection of the late Mr. Ames, of Chicopee. It is a large fragment from a vein 12 mm. in thickness.

1896. Corundum. Pelham.

Crystals 1 to 1½ inches across, 2 inches long; from colorless, with spots of deep blue, to complete deep-blue color; gray, granular masses as large as one's fist; crystals deep blue in tourmaline and in andesite, but more commonly in a thick band of deep bronzy biotite bordering olivine rock. So much has been found by Mr. B. F. Merrill, who has done much for the mineralogy of the locality, that many bags have been sold for crushing. The finest mass was 6 inches long by 3½ inches wide. It was a single crystal, but with rude outer faces and in cross section showed alternate hexagonal bands of rich blue and gray a half inch wide. It was penetrated by a crystal of allanite a half inch square and an inch long, and the corundum is puckered radially from the allanite for the space of an inch; so that when broken across it has a most remarkable fibrous radiated structure surrounding the broken end of the allanite crystal. The perfect glassy and lustrous cleavage surface of the corundum crystal is continued up to the border of the radiated fibrous or puckered area, and is within this area replaced by a small conchoidal, quartz-like fracture. The specimen is in the collection of Amherst College.

COTUNNITE.

1866. **Cotunnite.** Southampton lead mine.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 247.
(This is anglesite.)

CUMMINGTONITE.

1824. **Cummingtonite.** (Dewey.) Cummington.

See Amphibole.

1860. **Cummingtonite.** (Rammelsberg.) Cummington.

See Rhodonite.

The first use of the word for the ferruginous actinolite is now established.

CUPRITE.

1835. **Red oxide of copper.**

Mentioned as occurring in new red sandstone and trap, but no locality given.

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. XLVII, p. 323; Geol. Mass., p. 225.

1843. **Red oxide of copper.** Whately.

Coating specimen of native copper.

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. XLVII, p. 323.

1882. **Cuprite.** Deerfield.

In minute octahedra superficially altered into malachite; occurs on datolite in fissures of diabase.

B. K. Emerson: Deerfield dyke and its minerals; *ibid.*, 2d series, Vol. XXXIV, p. 280.

CYANITE.

1818. **Cyanite or sappare.** Deerfield.

In mica-slate; discovered by Dr. S. W. Williams.

E. Hitchcock: Geol. of Conn. River; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1820. **Sappare.** Chesterfield.

Near line between Conway and Deerfield, a few miles east of the village of Conway.

A. Eaton: Index, p. 145.

1823. **Cyanite.** Chesterfield, Granville, Plainfield.

Chesterfield, in loose masses in mica-slate, where its bladed or imperfect prisms are 2 feet long (Hunt). Granville (Dewey), Plainfield (J. Porter).

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 219.

1823. **Kyanite.** Chester and Chesterfield.

Very dark, in mica-schist.

J. Porter: Loc. Min., *ibid.*, p. 248.

1824. **Cyanite.** Chester or Norwich.

"A curious variety occurs here in very fine, soft mica-schist resembling potstone, often in hemitrope crystals; color grayish blue."

E. Emmons: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VII, p. 254.

(The locality is uncertain, because he has mentioned Norwich in the sentence before and was writing from Chester. The description of the rock agrees best with Chester. I have, however, found the grey variety abundant in the sericite-schist just south of Chester.)

1824. **Cyanite.** Chester.

In common mica-schist. A darker variety than the common in dark mica-schist, generally in single prisms (Emmons). Blandford, Granville.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 40.

1825. **Cyanite.** Near Westfield.

Abundant to the north and west of the village of Westfield—the green and blue varieties; green in quartz and blue in mica-schist; blue not perfect crystals.

Emerson Davis: Min. Loc.; *ibid.*, Vol. IX, p. 252.

(This refers to the towns mentioned above. The mineral does not occur in Westfield except along the west line.)

1825. **Kyanite.** Cummington.

Rare, large, well-defined crystals in mica-slate, with garnet, quartz, and black mica.

J. Porter: Min. Loc.; *ibid.*, Vol. IX, p. 55.

1825. **Cyanite.** Conway, Chesterfield, Chester, Cummington, Blandford, Granville, Middlefield, Plainfield.

S. Robinson: Cat. Am. Min., p. 37, ff.

1827. **Cyanite.** Chesterfield.

Crystals azure-blue, 18 inches long, 2 to 3 inches broad.

A. Nash: Lead veins of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 241.

1828. **Sappare.** Chesterfield.

One mile north of meeting-house, on land of Mr. Searle. In veins in bowlders of mica-schist; doubtless is in place below; not good specimens now. Mr. Searle usually keeps a supply on hand to furnish travelers.

E. Hitchcock: Min. Loc.; Am. Jour. Sci., 1st series, Vol. XIV, p. 216.

1835. **Sappare.** Chesterfield, Blandford, Worthington, Middlefield, Deerfield.

E. Hitchcock: Geol. Mass., p. 345.

1835. **Rhœtizite.** Blandford and Russell (Emmons).

Ibid.

1844. **Kyanite.** (*Epimecius cyaneus*.) Chesterfield, Worthington, Blandford.

J. D. Dana: Sys. Min., p. 375.

1844. **Cyanite.** Chesterfield.*Analysis.*

SiO ₂	42.56
Al ₂ O ₃	57.00
Loss	.44
	100.00

Same as fibrolite (Vanuxem).

F. Alger: Alger's Phillips Min., p. 108.

1866. **Kyanite.** Northfield. On Northfield Mountain, road to Erving.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

1877. **Cyanite.** Blandford, Russell.

North Blandford road, in hydromica-schist. South of Blandford Centre on West Granville road, between two brooks.

Russell, west of river on bank just below the old railroad bridge. Large crystals, gray, in schist; 100 by 25 mm.; fine blue in small segregated granite vein adjoining.

1882. **Cyanite.** Worthington.

On the old Rufus Smith farm, now owned by Spencer Stewart, 3 miles southwest of center. Also in ledge where Rev. Mr. P. W. Lyman has blasted it out, 40 rods southeast of R. Smith's house; also one-half mile west of this house in bowlders.

1882. **Cyanite.** Northfield.

Deep rich blue in single crystals and fibrous gray; top of gulf road, where it goes down to Erving.

W. E. Webster's collection, Northfield.

1883. **Cyanite.** Chester.

In fine large mass in bowlder about one-half mile southwest of Chester Center.

E. J. Whitaker, class of '83, Amherst College.

1890. **Cyanite.** Chesterfield.

"Cyanites were found in the early part of the century at Chesterfield, Mass., where some of the finest mineralogical specimens were obtained. An example of these, a mass measuring 10 by 6 inches, and consisting of distinct crystals over 3 inches long, piled one upon another, is in the British Museum at South Kensington, in London. The crystals are all distinct, of a fine blue color, and would cut into small mineralogical gems."

G. F. Kunz: Gems and precious stones of the U. S., p. 176.

CYMATOLITE.

MUSCOVITE-ALBITE PSEUDOMORPHS.

1825. **Talc.** Goshen.

With the rose mica occurs "a beautiful white talc, which I believe has not been credited to this locality."

E. Hitchcock: Am. Jour. Sci., Vol. IX, p. 21.

1867. **Cumatolite.** Goshen.

"Cumatolite (Kuma, Gr. a wave, from its undulating surface. $H. = 1.5$. Gr. $= 2.74$.) Occurs in long prismatic forms, seemingly the continuations of spodumene crystals, of which they constitute (at one end) about half the length. Cleavage micaceous in one direction, which is constantly intermediate between the two perfect prismatic cleavages of the contiguous spodumene. There is no blending of the two minerals, but simply a contact where the two crystals meet. Color white, luster pearly or that of satin. Thin laminae transparent, inelastic. No appearance of having resulted from decomposition or metamorphosis of spodumene. Both minerals are perfectly fresh and lustrous throughout. Gives off no moisture or fluorine by heat. Before the blowpipe is nearly infusible except at the thinnest points, which only become rounded. Slowly dissolved by borax into a clear glass; with soda gives when cold an opaque white one. Cobalt produces an intense blue. No reaction of lithia, even when fused with bisulphate of potash. Scarcely attacked by acids. Fuses with carbonate of soda into a colorless mass, which gave about two-thirds silica, abundance of alumina, and not more than 1.5 per cent lime, with traces of magnesia. Neither potash nor soda were sought for. Found at the indicolite locality in Goshen, Mass.

"C. U. SHEPARD.

"AMHERST COLLEGE, May 24, 1867."

C. U. Shepard: Private publication.

1867. **Cumatolite.** Goshen.

Correspondence with Prof. J. D. Dana, May 24, 1867; quoted in Dana's Sys. Min., p. 455.

1868. **Pihlite.** Goshen, Norwich.

Analysis by B. S. Burton. Cymatolite quoted as a synonym (Dana's Sys. Min., p. 455), with changed spelling.

"The locality (Norwich) is a mistake, as Professor Shepard says he found it only at the Barrus locality in Goshen."

A. A. Julien: Ann. N. Y. Acad. Sci., Vol. I, p. 327.

1871. **Cymatolite.** Chesterfield.

Analysis (imperfect and retracted) in the article "Spodumene and its alterations," p. 327; occurs in a quartzose segregation of a granite vein on a supposed new mineral from Chesterfield.

A. A. Julien: Am. Chem., Vol. I, p. 300.

1877. **Cymatolite.** Goshen.

Crystals 2 inches long in bluff north of Lily Pond.

1877. **Aglaite.** (A. A. Julien.) Chesterfield.

"A new mineral species with interesting relations to pihlite and cymatolite." Name proposed and analysis given the same as below, except that the water is given as 3.01, part of which is below assigned to organic matter.

A. A. Julien: Eng. and Min. Jour., Vol. XXIII, p. 217.

1879. **Cymatolite.** Goshen.

A preliminary notice in which the author restores the original name, cymatolite, but retains the name aglaite for the peculiarly brilliant and micaceous variety found at Goshen.

Analysis.

SiO ₂	58.11
Al ₂ O ₃	24.38
Fe ₂ O ₃	1.66
MnO	.18
MgO	.75
CaO	.48
Li ₂ O	.09
Na ₂ O	2.57
K ₂ O	8.38
Organic matter	.43
(?)	2.58
	99.61

A. A. Julien: On the composition of the cymatolite from Goshen; Am. Jour. Sci., 3d series, Vol. XVII, p. 398.

(This small, micaceous variety found at Goshen was exactly the original cymatolite of Shepard.)

1879. **Cymatolite.** Goshen. Chesterfield.

Goshen; on the Manning farm; impure yellowish. On the Barrus farm, variety aglaite, always in continuation of (never as a crust on) the prisms of spodumene; with flat micaceous structure. At Chesterfield Hollow, Chesterfield, in crusts, often of large size, of fibrous micaceous structure, with wavy cleavage. A series of analyses of both the Goshen and Chesterfield mineral and a most elaborate discussion of its chemical formula are given; then a microscopical description follows. "The fibers of cymatolite seem to spring from those of the spodumene," or rather of the killinite, which latter seems to occupy the position of the β —spodumene of the next article by Brush and Dana. (See p. 346 of this article, and figures.)

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci., Vol. I, p. 327.

1879. **Undetermined pseudomorph.** West Chesterfield.

Pseudomorphs after spodumene rather indistinct.

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci., Vol. I, p. 349.

1879. **Albite after spodumene.**

This form, generally mixed with a little muscovite and less quartz, is a mere variety of the albitic granite below, and is rarer than the variety where muscovite prevails to the exclusion of the other constituents.

A. A. Julien: Ibid., p. 349.

1879. **Albitic granite after spodumene.**

The pseudomorphs, most conspicuous in size, even more so than those of cymatolite, consist of a vein granite made up of muscovite, albite, and quartz in varying proportions even within the same pseudomorph, with manganese, garnet, ærstedite, beryl, etc., occasionally interspersed.

The large cymatolite columns generally pass at one end into mixtures of this character, and enormous masses of 1 or 2 hundredweight have been formed. They consist of an aggregation of perhaps only two or three pseudomorphs of this kind, rudely, but in places distinctly, shaped, each from several inches to nearly a foot in diameter, and from 1 to nearly 3 feet in length. Various transitions were observed in the deposition of these materials, such as huge pseudomorphs of which a large core consisted of a coarse aggregate of mica crystals with an outer crust, one-half inch thick, of cymatolite; in other cases of grayish-white quartz.

The chemical explanation of this change seems to be: "A splitting up of two molecules of the bisilicate spodumene by a simple transference of two atoms of silica from one to the other into one molecule of muscovite and one of albite, the lithium being replaced by potassium or sodium out of the solution during this change. This may be represented: Two molecules spodumene, 1 molecule muscovite, 1 molecule albite, $R_4Al_4Si_8O_{24} = R_2Al_2Si_2O_8 + Na_2Al_2Si_6O_{16}$."

A. A. Julien: Ibid., p. 348.

1880. **Cymatolite.**

The supposed mineral is proved to be an intimate mixture of albite and muscovite. The spodumene changes into " β -spodumene," a pegmatitic mixture of albite and a new mineral, eucryptite, which latter has changed into muscovite. The cymatolite is thus a cryptocrystalline albitic granite.

G. J. Brush and E. S. Dana: The spodumene of Branchville; Am. Jour. Sci., 3d series, Vol. XX, p. 267.

1892. **Cymatolite.**

"The cymatolite from Goshen was earlier (Eng. Min. Jour., XXII, 217) called aglaite by Julien."

E. S. Dana: Min., 368.

(This should read "Chesterfield" for "Goshen," "XXIII" for "XXII," and "later" for "earlier" since cymatolite was published ten years earlier than aglaite.)

DAMOURITE.

See Muscovite, 1846.

DATOLITE.1876. **Datholite.** Greenfield.

C. U. Shepard: Cat. of Min., within 75 miles of Amherst College, p. 4.

1882. **Datolite.** Deerfield.

The datolite is second only to prehnite in abundance at the new cutting, and surpasses all the minerals occurring here in beauty, perfectly pellucid crystals up to 12 mm. long being not uncommon, and many of the same showing a great range of rare faces and curious and perplexing distortions. It occurs also in thin veins, developing no crystals on the north side of the river and rarely in the amygdules in the light-gray diabase. The mineral fills the veins often completely with a white saccharoidal deposit from 10 to 50 mm. thick, with only here and there cavities in which fine crystals have come to development. It rests sometimes upon the trap itself, which is there quite fresh, and where slickensides occur they are of light-gray color, due to the mixture of datolite and trap, without the appearance of any of the chloritic or serpentinous products of decomposition which darken the same formation in the prehnite. More commonly it rests upon a thin layer of massive prehnite, rarely with several alternations of datolite and prehnite in calcite or upon the thick layers of spindle-shaped crystals of the former mineral, where the separate attached crystals reach the greatest perfection. The crystals of datolite, which resemble those of Farmington in their glassy clearness and general habit, are remarkable for the great number of faces represented and for the distinctness of the types into which they are grouped, as well as for the manifold and intricate forms produced by the unique development sometimes of single faces and sometimes of all the faces on one side of the vertical plane.

The following is a list of all the forms presented, arranged according to the table given by E. S. Dana¹: $i-i$ (a), $i-i$ (b), 0 (c), I (M), $i-2$ (o), $i-3$ (l), $1-i$ (u), $-\frac{4}{3}i$ (v), $-(x)$, $-(s)$, $4-i$ (II), $2-i$ (ξ), $\frac{1}{2}i$ (Ω), $1-i$ (σ), $\frac{4}{3}i$ (t), $2-i$ (g), $4-i$ (m), -4 (n), 2 (ε), $\frac{4}{3}$ (λ), 1 (μ), $\frac{4}{3}$ (κ), $-6-3$ (q), $-4-2$ (ϑ), $4-2$ (Θ), $12-\frac{3}{2}$ (π), $-16-2$ (R), $-8-2$ (β), $-4-2$ (Q), $-\frac{8}{3}-2$ (U), $-2-2$ (γ), $2-2$ (T), $\frac{8}{3}-2$ (i), $8-2$ (B), $\frac{8}{3}-2$ (C), [new], $\frac{3}{2}-3$ (E), $\frac{5}{2}-3$ (F), $\frac{5}{2}-5$ (K), $\frac{9}{4}-9$ (G).²

For convenience of description the crystals may be divided into three types:

I. *The regular.* In this almost spherical forms are produced by the equal development of a large number of faces. In one crystal x , ε , m were slightly larger than the rest; a , M , n , o , β , Q , equally developed; c , q , B , very small.

Another very stout, prismatic and resembling the Andreasberg crystals somewhat in the distribution of its faces, except that the elongation in the direction of the clinodiagonal axis was only slight, had the faces x , ε , λ , g , m , largest; ii , M , -4 , β , Q , O , μ , ii , about equal; u , v , q , ϑ , ξ , o , π , a , x , smaller.

A third was formed by the nearly equal development of a , x , g , m , ε , λ , μ , M , o , n , β , B , with O , s ($-6i$) q , and γ subordinate.

A fourth minute but very beautiful crystal was unique for this locality in having the face o large and square and ii elongated vertically, the faces g , m , u , x , a , n , M , ε , λ , o , β , Q , U , a , about equally large, ξ , q , μ , i , F small.

Several of the larger crystals of this type showed a new face in the zone λ ($\frac{4}{3}$), g ($2-i$), and o ($i-2$), c (O) $\frac{8}{3}-2$, to which I have in the preceding list applied the letter C.

II. *Prismatic type.* By the great enlargement of x and two opposite faces of m a prism of 116° is formed, elongated in the direction of the axis of the zone x , o , m , the sharp edges of which are beveled by n and o elongated into narrow planes. The other planes are grouped in a very confusing

¹Tsch. Min. Mittheil., 1874, p. 5.

²This list has been corrected, as several misprints occurred in the original from lack of proof reading.

1882. **Datolite**—Continued.

way around the ends of this prism. The uniform dullness of the face x is a characteristic feature.

The crystal under this type which was richest in faces showed the following combination: $a, b, c, M, o, x, g, m, n, \varepsilon, \lambda, \mu, q, \beta, Q, U, B, a, i$; another lacked the faces b, k , and those in the zone B, o, β . Other crystals showed the faces R, π , and τ in traces.

III. *The tabular type.* The roughened faces of x are large and nearly circular and approached so as to reduce the crystal to a thick plate, around the edge of which the other faces are placed. The crystals of this type resemble closely the Haytorite pseudomorphs, some of them having the same faces in the same relative development as in the latter, others being even richer in forms than any I have seen described from the Haytor mine.

One crystal contained twenty-eight distinct forms, several only as fine lines, but all capable of quite close measurement. The crystal was peculiar in having the face a striated in two directions, forming a series of V's, as is common with the face o from other localities. The latter face is here finely polished.¹ The forms present were $a, c, M, o, u, \acute{s}, II, \xi, \Omega, \sigma, \gamma, m, n, \varepsilon, \lambda, \mu, x, g, \theta, \beta, Q, U, a, B, E, F, K, G$. Another crystal of this type went to the extreme of simplicity, being bounded by the faces $a, c, M, o, \xi, g, m, n, \varepsilon, \lambda, \mu, q$, all quite large except q and O , and the face ξ unusually large and shield shaped.

Similar tabular forms have been recently described from the spheres of chalcedony from Theiss in Tyrol.²

Inclosures in datolite. Calcite. When the datolite is thrown in acid, much calcite is dissolved and a vesicular mass left; and similar pieces are found in the vein itself, showing that the same operation has been performed by natural agencies.

Selenite? Barite? In the thick veins the minerals are often abundantly gashed by the removal of broad, thin blades of some mineral, possibly selenite or barite, and the surfaces drused over by minute, very distorted crystals of datolite.

Axinite. Some of the finest crystals of axinite occur in the datolite. The crystals are here sometimes short, stout prisms.

Prehnite. Small portions of prehnite are inclosed rarely in the lower portion of the datolite; also small patches of the chloritic mineral identical with that derived from the decomposition of the former.

B. K. Emerson: The Deerfield dyke and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 352.

1882. **Botryolite.** Deerfield.

One cavity of the trap large and nearly globular, with vesicular walls, was filled with datolite, which was compact within the vesicles of the trap, but above was fine-granular, like loaf sugar, and much gashed, and at the surface coated with a layer of small botryoidal or globular botryolite, which would have been taken for hyalite if it had not proved fusible with green flame before the blowpipe.

Ibid., p. 355.

1888. **Datolite.** Deerfield.

Dr. O. Luedeke: Ueber Datolith, eine mineralogische Monographie; Zeit. für Naturwissenschaften, Vol. LXI, p. 235.

¹ This striation was apparently parallel to the intersection edges which the face a produced would make with o and $i-i$.

² C. Vrba, Zeitsch. Kryst., Vol. V, p. 425.

1888. **Datolite.** Cheapside, north side of Deerfield River. Northampton.

In changing the location of the Fitchburg Railroad, a deep cutting was made in the Deerfield trap directly opposite the above locality and on the same sheet, separated only by the width of the river. Many large cavities of fine crystals were found. The locality differed markedly from the one on the other side of the river, as datolite was here the only mineral. The crystals were often larger than at the other locality, generally of the regular type and not quite so transparent, and showed a faint green tint.

DELESSITE.

See Diabantite.

DEWEYLITE.

1826. **Deweylite.** Middlefield.

Emmons: *Man. Min. and Geol.*, p. 134.

1835. "**Deweylite?**"

In serpentine in Russell, on bank of Westfield River, one-half mile north of serpentine location in Westfield.

E. Hitchcock: *Geol. Mass.*, p. 370.

This was probably the bastite from the Atwater quarry.

1835. **Kerolite.** Middlefield.

"The compact variety, deweylite (Emmons), at Middlefield in seams and irregular veins. Pseudomorphoses after quartz of considerable dimensions and of grayish-white color."

C. U. Shepard: *Min.*, 1st edition, Part II, Vol. I, p. 292.

1841. **Deweylite.** Russell, Middlefield.

E. Hitchcock: *Geol. Mass.*, p. 618.

1852. **Kerolite (Deweylite).** Middlefield.

C. U. Shepard: *Min.*, 3d ed., p. 146.

1876. **Deweylite.** Middlefield.

C. U. Shepard: *Cat. of Min. within 75 miles of Amherst College*, p. 3.

1883. **Deweylite.** Middlefield.

Under the microscope a delicate micro-botryoidal and laminated structure, wholly amorphous and winding in sheets among the remains of the serpentine, in which and from which it is formed.

DIABANTITE.

1818. **Green earth.** Deerfield.

Small quantity in amygdaloid.

E. Hitchcock: *Geol. Deerfield dyke and its min.*; *Am. Jour. Sci.*, 1st series, Vol. I, p. 113.

1823. **Chlorite.** Deerfield, Greenfield, Gill.

In greenstone amygdaloid; it fills two-thirds of the cavities in some varieties of greenstone, and to the naked eye has a radiated aspect, but Professor Dewey remarks that it does not appear to be radiated under a magnifier, great or small, but to consist of folia curiously arranged, often with no regularity, their length somewhat greater than their breadth.

Green earth.—"A part of the chlorite described above appears to belong to this species."

E. Hitchcock: *Geol. Conn. River*; *ibid.*, Vol. VI, p. 28.

1826. **Radiated chlorite.**

With chlorophæite.

E. Hitchcock: Ibid., Vol. X, p. 393.

1841. **Chlorite.** Greenfield, Deerfield, South Hadley, Northampton, West Springfield.

"A dull-green foliated mineral, which appears to be chlorite. The folia have in general a radiated structure and sometimes invest calcareous spar. A little below Turners Falls, in Gill, just at the mouth of Fall River, on the east bank, is the best locality of this mineral with which I am acquainted. More frequently the cavities are occupied by earthy chlorite * * * along the east side of the ranges of greenstone."

E. Hitchcock: Geol. Mass., p. 660.

1876. **Delessite.** Greenfield (Turners Falls).

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 4.

1882. **Diabantite.** Turners Falls, Springfield.

The chloritic mineral, so uniformly and abundantly disseminated in the diabase of the valley, was entered in the catalogue of the State collection by Dr. Hitchcock as foliated chlorite, Turners Falls, and a paler pulverulent variety, as earthy chlorite, Springfield. That the mineral is chemically identical with that analyzed by Hawes, and named diabantite by him, is extremely probable in view of their identity in all physical and especially optical properties, and of the monotonous similarity of the many diabase dikes of the Connecticut basin, in which both occur. That the mineral is distinct from delessite, as the word is used by Zirkel, Rosenbusch, and Heddle, is much less certain.

It is the earliest product of the decomposition of the diabase, and proceeded doubtless from the alteration of the augite. In one case I found a mass having the shape of an augite crystal filled with magnetite toward the outside and polarizing as a single individual, but possessing the bright-green color and the strong dichroism of diabantite. It is disseminated in comparatively small amount through the mass of the rock between the feldspar crystals, and thus in the place of the augite, much more abundantly in the steam cavities and shrinkage cracks with which the rock abounds. It generally coated the empty amygdaloidal cavities first with a quite thick ($\frac{1}{2}$ –1 mm.) foliated-radiated layer with minute, delicate botryoidal surface. Several such layers sometimes followed each other, and then the center became filled with a confused granular mass of the same material, the whole making a very pleasing effect under the microscope with its bright-green color and striking dichroism. Under crossed nicols this central granular portion often assumes a deep chlorite green studded with bright colorless spots (calcite?), and maintains this color through a whole revolution of the object, the bright spots being alternately extinguished. Sometimes, in the gray mottled diabase, a layer of magnetite was interposed between the layers of diabantite, and rarely large distinct crystals of magnetite appear wholly surrounded (in section) by diabantite, and in one case a fine large feather of magnetite projected into the diabantite. The long feldspar crystals, also, which border the cavity, often project freely into it and are then perfectly and more complexly terminated than when in the mass. The diabantite folds around and does not penetrate them. Often the center of the cavity is filled with calcite, impregnated with diabantite, so as to produce a pegmatitic appearance on cleavage faces, or with finely fibrous prehnite, and this also is for a greater or less distance toward the center blackened by the abundance of the diabantite which it has inclosed.

1882. **Diabantite**—Continued.

On the other hand, where over the botryoidal layer of diabantite there appear quartz, datolite, natrolite, sphalerite, or other sulphurets, they are entirely free from this impregnation. In the broad mineral-bearing fissures the diabantite often impregnates layers of scaly or fibrous prehnite 1 to 5 mm. thick over considerable surfaces so that a black or blackish-green mass results, often abundantly slickensided, which so resembles a very fine-grained scaly or fibrous schist that I supposed it to be formed by the pulverizing of the trap by friction and the cementing of the powder by prehnite, until the microscope made known its true character.

Farther north, on the dike opposite Turners Falls, the large flattened cavities are lined with a botryoidal layer, 1 mm. thick, of black-green diabantite, with crystals of chalcopyrite, blende, and albite upon it. The interior is very often filled with a dark olive-green fine-granular mixture of crystals of diabantite, which can be shaken out of the cavity as a fine powder, each grain of which appears, under the microscope, as beautifully vermicular as the helminth of the older rocks.

The paragenesis of the mineral is thus quite definitely fixed. It was the first product of the decomposition of the diabase, and its formation ceased not very long after calcite and prehnite began to be deposited in the cavities and fissures. As the formation of the latter minerals was attended by quite energetic decomposition of the trap, the formation of the diabantite, occurring still earlier, may well have been promoted by the increased chemical activity of the waters during the cooling of the trap after its solidification. The mineral seems to me plainly of secondary formation, and I can see no good ground for thinking that it was formed and deposited where we find it during the rise of the lava through the sandstones. The cavities flattened and fluidally arranged in the lower part of the mass, with well-terminated feldspars projecting into them, and growing very abundant and graduating into long vertically placed tubes in the upper portions, have certainly been formed by steam and can not have been filled till after solidification of the rock. This is much more certainly the case with the broad fissures that extend across the whole dike, which seem for a time to have furnished a passageway for boracic-acid springs, and in which the diabantite must have been formed much as were the calcite and prehnite that it has impregnated. The filling of the cavities also with several concentric and botryoidal layers, sometimes separated by calcite, would indicate slow deposition from water.

The great amount of protoxide of iron in the mineral does not seem to me to need for its explanation the assumption that it is an original constituent of the rock. The waters brought up in the lava, on becoming liquid, or the waters which reached the bed after percolating through the bituminous sandstones of the valley, may have been deprived of oxygen and able to exert strong solvent activity, without peroxidizing the iron of the augite. In discussing a mineral which seems to be identical with our diabantite and which forms the first coating of the amygdules of the phillipsite-bearing feldspar basalt of Salesl, Von Zepharovich¹ derives the same from sphærosiderite, the radiated and concentric structure and the botryoidal surface resembling in miniature that common in the carbonate. A cellular structure and traces of rhombohedral forms were also observed. I have seen here no traces of any such crystal forms. The cellular or excavated structure occurs frequently and can be produced in fresh specimens by acid, by the removal of calcite. The occurrence of the mineral in fresh prehnite and calcite would militate against its being here a pseudomorph after siderite.

¹ Zeitsch. Kryst., Vol. V, 1880, p. 98.

1882. **Diabantite**—Continued.

Products of the decomposition of diabantite—From its great content of ferrous oxide the mineral is very prone to decomposition, and in sections cut near the weathered surface of the rock its color has become red-brown, its strong dichroism is gone, and it shows only the faintest aggregate polarization. Sometimes a cavity shows the exterior changed and brown, the interior bright-green, with sharp lines of demarcation. In the large amygdules, masses of gold or bronze yellow, sometimes light straw-yellow, can be obtained, which exfoliate voluminously under the blowpipe, and then by a sharp explosion throw off the foliated portion and begin the operation anew. It is a *diabantite vermiculite*. At the end of this series of changes only a small quantity of limonite remains.

When a slide of the diabase is treated with hydrochloric acid, both the fresh and the altered diabantite are decomposed and white silica remains behind in plates having still the shape and arrangement of the original mineral. This is also the case with the vermiculite out of the crystalline rocks in Pelham.

Similar amygdules occur in the compact diabase, having a white color or being in part still green and dichroic, and having exactly the arrangement of the diabantite. These are silica, I have no doubt, and have been produced by some natural process analogous to the artificial one employed above. The white portions show marked aggregate polarization in white and black, but without bright colors.

B. K. Emerson: The Deerfield dyke and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 198.

DIALLAGES.

1823. **Diallage**. Conway? Granite.

E. Hitchcock: Geol. Conn.; Am. Jour. Sci., 1st series, Vol. VI, p. 227.

(This was possibly zoisite.)

1824. **Diallage**. Chester, Middlefield.

Chester, in diallage rock? Resembles metalloid diallage.

Middlefield. In small quantity and small grain in serpentine.

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 49.

(The first citation was probably a bronzy hornblende; the second, bastite.)

1868. See Enstatite.

1883. **Diallage**. Belchertown, Palmer.

In dark-green diallage granite, mostly changed to tonalite, in South Belchertown, and extending to Palmer.

Diallage with the usual brown-red inclusions as abundant and well characterized as in hypersthene from Pauls Island. Color green, fibrous; crystals just visible to the eye, then deep bronze like hypersthene, changing into a green fibrous uralitic hornblende, and this on the border into a scaly ring of bright-green chlorite.

DIALLOGITE.

See Rhodochrosite.

DIASPORE.

1865. **Diaspore**. Chester.

Needle-shaped crystals and blades on joints of emery blocks or sometimes embedded in compressed rounded masses quite within its substance; colorless, pink, violet; perfect crystals in open spaces.

C. U. Shepard: Report on Chester emery mine, p. 9.

1865. **Diaspore.** Chester.

With rose-colored amphodelite and with radiated epidote; distinct crystals and broad white laminae.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, pp. 112, 123.

1866. **Diaspore.** Chester.*Analysis.*

	No. 1.	No. 2.
H ₂ O	14.75	14.8
Al ₂ O ₃	80.75	83.0
FeO(TiO ₂)	4.50	.....
Fe ₂ O ₃ (TiO ₂) .....	.....	3.0
	100.00	100.00

C. T. Jackson: Ibid., Vol. XLII, p. 107.

1870. **Diaspore.** Chester.

Fine crystal, semitransparent and of rich hair-brown color, with a faint tinge of violet; sp. gr. 3.343.

Analysis.

H ₂ O	15.80
PO ₅	0.32
FeO(MnO)	0.38
Al ₂ O ₃ (dif.)	83.50
	100.00

C. U. Shepard: Min. Contrib.; Am. Jour. Sci., 2d series, Vol. L, p. 96.

1886. **Diaspore.** Chester.

Commonly in thin cleavage planes implanted upon a magnetite gangue, occasionally in very delicate acicular crystals and again in groups of crystals tabular, parallel to the brachypinacoid. The crystals are in fact composite, consisting of parts in nearly parallel position. They are deeply striated in the vertical zone and also in the zone *p e*. The observed planes are *a* (100, *i-i*), *b* (010, *i-i*), *h* (210, *i-2*), *L* (120, *i-2*), *e* (011, *i-i*), *s* (212, 1-2), *p* (111, 1), *U* (344, 1- $\frac{1}{3}$), *V* (122, 1- $\frac{1}{2}$).

E. S. Dana: Am. Jour. Sci., 3d series, Vol. XXXII, p. 388.

1890. **Diaspore.**

The old vein has been reopened and a shaft 150 feet deep sunk from the hilltop to the main adit. Much diaspore struck in thicker veins and very broad sheets. Single cleavage surfaces 4 to 5 inches broad, 9 to 10 inches wide. Great masses of loosely interlaced blades of the finest color and luster, from rich peach-blossom color to deep pink. Also broad surfaces of magnetite covered with tabular crystals of a rich, smoky, amethystine color. The finest specimen, a surface nearly a foot square, is owned by Mr. N. A. Howard, director of the Hampden Quarry Company.

DILLNITE.

1876. **Dillnite.** Pelham.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 3.

(Probably the clay-like material from the entire decomposition of the biotite at the asbestos mine.)

DOLOMITE.

1818. **Bitter spar.** Loudville. Southampton lead mine.
Fine specimens.
A. Eaton: Southampton adit; Am. Jour. Sci., 1st series, Vol. I, p. 137.
1820. **Dolomite.** Middlefield (E. Emmons).
Professor Dewey: Am. Jour. Sci., 1st series, Vol. II, p. 236.
1822. **Brown spar.** Leverett.
In vein of galena (Hitchcock).
Cleaveland: Min., Vol. I, p. 183.
1823. **Brown spar.** Leverett.
In vein of galena, pyrite, copper, and blende; grouped in rhombic crystals on quartz, the lamellæ usually rounded.
E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 212.
1823. **Rhomb spar. Dolomite.** Southampton, Middlefield.
Ibid.
1824. **Dolomite.** Middlefield.
In steatite; some fine white close-grained; others show cleavage distinctly; others yellowish-brown, high pearly luster, translucent; also in west of town with tremolite.
C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 34.
1824. **Rhomb spar.** Middlefield.
E. Emmons: Loc. Min.; *ibid.*, Vol. VII, p. 255.
1824. **Brown spar.** West Springfield.
With amethyst; found by Mr. Alonzo Chapin.
C. U. Shepard: Min. Loc.; *ibid.*, Vol. VIII, p. 235.
1825. **Rhomb spar.** Southampton.
In veins of galena.
Robinson's Cat., p. 70.
1826. **Rhomb spar.** Cummington.
Well crystallized in steatite.
J. Porter: Min. Loc.; *ibid.*, Vol. X, p. 18.
1835. **Bitter spar.** Middlefield.
Masses 3 to 4 inches across in delicate green talc, white or salmon-colored.
E. Hitchcock: Geol. Mass., p. 362.
1835. **Ankerite.** In West Springfield, in connection with the coal formation.
C. U. Shepard: Min., Part II, Vol. I, p. 25.
1835. **Brown spar.** Leverett; north mine.
Few crystals.
E. Hitchcock: Geol. Mass., p. 502.
1841. **Brown spar.** Leverett.
E. Hitchcock: Geol. Mass., p. 101.
1841. **Bitter spar.** Middlefield.
E. Hitchcock: Geol. Mass., p. 700.
1841. **Miascite.** Zoar.
Columnar variety of dolomite; in talcose schist.
Ibid.

1844. **Breunnerite.** Ibid.

Suggests that the rhombohedral crystals in steatite in Middlefield are of this species.

F. Alger: Alger's Phillips Min., p. 297.

1866. **Dolomite.** Chester.

In some veins with sapphire at Chester emery mine.

C. T. Jackson: Proc. Bost. Soc. Nat. Hist., Vol. XI, p. 32.

1876. **Ankerite.** West Springfield.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 2.

(The coal formation mentioned above (1835) is, of course, the dark Triassic shale, and the citation seems to be the same as that given by Professor Shepard, 1825, of brown spar with amethyst. This would make the locality to be the trap, as no amethyst has been found in the shales. I have found only calcite and siderite in the shale and trap of this region.)

1890. **Dolomite.**

Dolomite in fine cleavage specimens, associated with green talc, can be obtained at all the serpentine beds, especially at Middlefield and Rowe.

All the crystals I have seen from the lead mines have been calcite and not dolomite.

1895. **Dolomite.** Chester.

In running the adits in the talc bordering the emery vein fine, large specimens of dolomite have been obtained. They were large, white rhombohedra.

ENSTATITE.

1826. **Petalite** (?). Westfield, 5 miles west of Academy.

Unknown mineral suspected to be petalite; sp. gr. 23-25; scratches glass; fine foliated; melts to enamel with difficulty; no effervescence; in places rose red or purple; in 1-inch layers in serpentine; no lithia, but lime and magnesia.

E. Davis: Rocks and minerals of Westfield, and appendix; *ibid.*, Vol. X, p. 213.

(This is the enstatite from the Munns Brook locality on the line between Southwick and Granville or from bowlders of the same farther north.)

1835. **Scapolite.** Westfield.

Compact.

C. U. Shepard: Min., Part II, Vol. II, p. 175.

1841. **Scapolite** or **Petalite.** Westfield.

In serpentine in Westfield in vein nearly 1 foot wide.

Ibid., p. 618.

1841. **Anthophyllite.** Westfield.

"Also a mineral which I am disposed to refer to anthophyllite."

E. Hitchcock: Geol. Mass., p. 618.

1868. **Diallage.** Westfield and Blandford in serpentine.

J. D. Dana: Sys. Min., p. 220.

(The Westfield citation is plainly the above; that from Blandford I suppose to be Shepard's "anthophyllite," which I have referred to actinolite.)

1889. **Enstatite.** Granville.

The coarse enstatite rock of Munns Brook, Atwater's quarry, and Westfield River is described in the monograph on the region, and the large crystals of enstatite, superficially altered to bastite and talc, which occur in bowlders at the cemetery in Granville and just north in the great

1889. **Enstatite**—Continued.

ledge in the swamp east of J. Downey's and also south of J. M. Cooley's in the northeast of Granville, where crystals 6 inches long can be obtained. are fully discussed.

1893. **Diallage**. Westfield and Blandford in serpentine.

C. Hinze: Min., p. 1091.

EPIDOTE.

1818. **Epidote**. Deerfield, Shutesbury, Leyden, Pelham (poor).

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. **Epidote**.

Tolland (Webster); Shutesbury, small crystals in gneiss. In many other places not very interesting. Shelburne, arenaceous. East Shutesbury, Leyden, Shelburne, Buckland, Whately, Belchertown, Monson, in hornblende and greenstone slate.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 223.

1824. **Epidote**. Pelham.

C. U. Shepard: Min. Loc.; *ibid.*, Vol. VIII, p. 235.

1824. **Epidote**. Worthington, upon hornblende rocks; Middlefield, Chester.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 44.

1825. **Epidote**. Belchertown.

In greenstone (Eaton).

Robinson's Cat. Min., p. 36.

1825. **Epidote**. Plainfield, crystallized or granular. Williamsburg, in quartz, remarkably beautiful.

J. Porter: Min. Loc.; Am. Jour. Sci., 1st series, Vol. IX, p. 54.

1827. **Epidote**. Williamsburg.

In quartz in layers, with small garnets as a focus, around which the epidote is radiated.

A. Nash: Lead mines of Hampshire County; *ibid.*, Vol. XII, p. 259.

1835. **Epidote**. Williamsburg, Middlefield, Chester, Cummington, Worthington, Plainfield.

In mica-slate embedded in quartz with hornblende.

E. Hitchcock: Geol. Mass., p. 346; Geol. Mass., 1841, p. 606.

1841. **Epidote**. Pelham, with schorl in gneiss.

E. Hitchcock: Geol. Mass., p. 637.

1844. **Epidote**. (*Carbunculus rhomboideus*.) Rowe.

In hornblende slate.

J. D. Dana: Sys. Min., p. 379.

1865. **Epidote**. Chester emery vein.

Frequent, especially in the vein on both sides the smaller Deerfield River; light yellowish-green; 1 to 2 inches long by one-eighth to one-fifth inch wide, with margarite; also radiated pistachio-green with diaspore on cross joints of vein rock.

C. U. Shepard: Report Chester emery mine, p. 11.

1866. **Epidote**. Northfield; on Northfield Mountain.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

(Only unimportant traces of epidote were found by me during a careful survey of Northfield Mountain, and the best local mineralogists know of no important locality there.)

1882. **Epidote.** Pelham. Ward's quarry, in gneiss.

In elongated, flattened, and striated blades and sheaf-like aggregations of blades, blackish-green at one end and pistachio-green at the other.

1882. **Epidote.** Deerfield.

"Occurs rarely low down in the prehnite; more commonly in drusy surfaces in its upper part, or spread in delicate tufts of flat blades upon the spindle-shaped crystals. It is included also with interrupted crystallization in the calcite which follows upon the prehnite. The maximum size of the crystals is 3 mm. They are mostly thick plates, and under the microscope show as brilliant luster and as rich dark-green as the specimens from the Dauphiny. It incloses as an aggregate prehnite, sphalerite, chalcopryite, and calcite, but the separate crystals are perfectly pure and transparent. The thickest crystals are deep pistachio-green; the thin plates are deep brown-red, sometimes half colorless."

B. K. Emerson: Deerfield dyke and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 350.

1883. **Epidote.** Pelham; Gaylord's pasture.

In fragments of large boulder west of the west serpentine knob, 1 mile south of red house; the boulder made up wholly of epidote and calcite; quite good crystals an inch long; twins. Most of the epidote crystals in collections from Pelham are from this locality. The beautiful slickensided surfaces of light-green polished epidote come from the gneiss in the west of Pelham.

1885. **Epidote.** Rowe.

Curved, thick, columnar forms in pyrite in J. M. Davis & Co.'s mine.

Analysis.

SiO ₂	38.20
Al ₂ O ₃	24.62
Fe ₂ O ₃	12.20
MnO	.57
MgO	.13
CaO	21.59
Alk	.37
H ₂ O	2.16
Res	35.00
	100.19

A. G. Dana: Gahnite of Rowe; Am. Jour. Sci., 3d series, Vol. XXIX, p. 456.

1892. **Epidote.** Rowe.

In the pyrite mine with gahnite.

E. S. Dana: Min., p. 520.

1885. **Epidote.** Chester, Worthington, Hawley, Warwick, Hunting-
ton.

Chester. On a flat fissure surface of the emery an acicular-radiate growth, the blades being 5 cm. long and of a fine light pistachio-green. Also beautiful elongate-bladed crystals of deeper color on granular chlorite. The finest specimens are in the collection of Mr. Ames, of Chicopee.

Worthington. Below Cushing's gate, 1 mile west of Center. Fine crystals occur in the chlorite schist of the Hawley series.

¹ Two analyses.

1885. **Epidote**—Continued.

Hawley. M. V. Cressey's farm. Large boulders full of large interlaced blades, often much warped, of deep-green epidote in sericite-schist of the Hawley series.

Warwick. Crystal hill. On the blind road running south from the village to Hastings pond. Great masses of a rock consisting of massive epidote of rich pistachio-green and deep-red garnet, associated with hornblende schist. Drusy surfaces of very dark epidote crystals of complex form occur.

Huntington. A half mile south of the East Branch. From a calcareous layer in the Conway schist, associated with coarse biotite. Pearl-gray crystals which strongly suggest zoisite. I found the angles of epidote by many measurements. Fine crystals nearly an inch across and two inches long, elongated in the direction of *b* and twinned, with the twinning plane *a* often multiple twinned. From the rarity of the color these crystals have sold for high prices.

EUCHLORITE.

1876. **Euchlorite**.

See Biotite.

EUMANITE.

1851. **Eumanite**. Shepard. Chesterfield.

Only a single minute crystal less than a grain in weight is known. Described and figured.

Editor's note (J. D. Dana?): Remarks the crystallographical similarity with topaz.

Mineralogical notices: Mineral species described by Prof. C. U. Shepard; Proc. Am. Assoc. Adv. Sci., Vol. IV, p. 317; Am. Jour. Sci., 2d series, Vol. XII, p. 211.

1851. **Eumanite**. Chesterfield.

"A few days since I received for examination from Mr. J. E. Teschemacher two minute crystals of the eumanite of Professor Shepard. They had long been in his cabinet.

"Eumanite and brookite are very closely similar, not only in physical characters, but also in crystallization."

J. D. Dana: On the crystallographic identity of eumanite and brookite; Am. Jour. Sci., 2d series, Vol. XII, p. 397.

1852. **Eumanite**. Chesterfield.

J. E. Teschemacher: On the angles of eumanite; Am. Jour. Sci., 2d series, Vol. XIII, p. 117.

1852. **Eumanite**. Chesterfield.

Description and figure. It appears to approach mengite.

C. U. Shepard: Min., 3d ed., p. 285.

1868. **Brookite**. (?) **Eumanite** (Shepard). Chesterfield.

Its chemical identity with brookite has not been ascertained.

Dana: Min., p. 165.

1876. **Brookite**. **Eumanite**.

Omitted, probably by oversight.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst.

1892. Eumanite.

Made to follow brookite as an imperfectly known species.

E. S. Dana: Sys. Min., p. 243.

The crystals upon which the species was founded were burned with the Shepard collection. As the mineral was not found by Julien in his exhaustive study of the tourmaline-bearing veins, the final determination of the mineral will probably be long delayed.

FASCICULITE.**1823. Fasciculite.** (Hitchcock. See Amphibole.)

This form of hornblende is so widely spread and characteristic in the Hawley schists that I have frequently used the word as a variety name in the geological discussion of the region.

FIBROLITE.

See Sillimanite.

FLUORITE.**1810. Fluat of lime.** Loudville.

First pointed out as such by Dr. Bruce, who has recently visited the spot. The prevailing color is green, but there are spots of purple and blue; the structure is lamellar; the green pieces are translucent, and a few cubical crystals occur.

B. Silliman: Bruce's Jour., Vol. I, p. 68.

1822. Fluato of lime. Deerfield.

Dr. Cooley has discovered in Deerfield fluato of lime, crystallized, I believe, in dodecahedrons, though I could not determine this certainly, as I had no glass when I examined them.

Letter of E. Hitchcock: Am. Jour. Sci., 1st series, Vol. V, p. 407.

1822. Fluorite. Near Northampton.

Dr. David Hunt: Editor's note; *ibid.*, Vol. VI, p. 188.

1823. Fluato of lime. Conway. Loudville. Deerfield.

Conway. Massive, light green; in small quantities in a vein in mica-slate. Loudville (Gibbs). Deerfield; in a loose stone with galena.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 212.

1841. Fluor spar. Conway. Loudville.

Green and purple. Hollow pseudomorphs in quartz cubes, drusy within and without.

E. Hitchcock: Geol. Mass., pp. 701-702.

1858. Fluor spar. West Springfield.

Purple, incrusting Triassic bituminous limestone.

E. Hitchcock: Cat. State collection; Rep. State Board Agri., p. xx.

1882. Fluorite. Northfield.

Purple; in fissures in quartzite in Ross's lead mine. Winchester line, Perchee Brook.

Bull. 126—6

1882. **Fluorite.** Deerfield.

"Emerald-green dodecahedra, like beads strung upon a satin thread, occur half embedded in and scattered over and among the last-formed fibrous prehnite, the crystals 0.03 mm. in length; also in the same relation to epidote and inclosed in the calcite which succeeds these. In a single case each emerald-green octahedra and cubo-octahedro, 0.03 mm. in size, in a drusy cavity in epidote and in green cubes upon prehnite."

B. K. Emerson: Deerfield dyke and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 350.

1886. **Fluorite.**

Northampton. Quarry south of W. N. Moore's, east of Florence.

In minute colorless cubes incrusting calcite, and in hollow quartz pseudomorphs after the same.

Hatfield. At lead mine. In small quantity on barite; purple.

Hawley. At the southern openings on the hematite vein; white cubes, 8 mm. across.

GAHNITE.

1885. **Gahnite.** Rowe.

In pyrite, at the mines of J. M. Davis & Co.

In outer portion of pyrite mass; greenish; up to three-fourths of an inch in size; O, ∞ O, twins.

Analysis.

Al ₂ O ₃	54.83
Fe ₂ O ₃	3.00
FeO	3.37
MnO	Trace.
MgO	1.93
ZnO	36.92
SiO ₂	.53
	¹ 100.58

A. G. Dana: On the gahnite of Rowe; Am. Jour. Sci., 3d series, Vol. XXIX, p. 455.

1888. **Gahnite.***Analysis.*

Al ₂ O ₃ and Fe ₂ O ₃	58.05
ZnO	35.90
Insoluble	1.49
	95.54

Gahnite or zinc spinel from Rowe, Mass., W. O. Crosby and C. L. Brown. Tech. Quarterly, Vol. I, p. 407.

GALENA.

1810. **Galena.** Southampton lead mine.

"Both of the broad foliated kind commonly called potters' lead ore, and of the small foliated kind usually denominated steel-grained ore; masses from a fraction of an inch to more than a foot in diameter; very pure and rich. Sometimes beautifully crystallized in cubes with blende on quartz; affords 50 to 60 per cent of lead, 12½ ounces per ton, silver."

B. Silliman: Bruce's Jour., Vol. I, p. 65.

¹ Mean of two analyses.

1818. **Galena.** Whately, Montgomery, Southampton, Hatfield.

Single crystals not in place in Greenfield.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 115.

1818. **Sulphuret of lead.** Southampton.

The fairest cubic crystals are slightly attached to the points of the quartz crystals. Found 774 feet from the mouth of the adit.

Amos Eaton: Southampton adit; *ibid.*, p. 136.

1827. **Galena.**

Leverett. One mile northwest of meetinghouse, $1\frac{1}{2}$ miles south of the first locality; in granite. Hatfield, 1 or 2 miles west of village, in syenite. Williamsburg, east part; granite, runs into Whately; one-half mile west of above, in granite. Whately, southwest part, in granite; on north line, in granite. Conway, east part, in granite. Williamsburg, northeast part, bowlders of granite. Goshen, 60 rods west of church, in mica slate. Northampton, southwest part. Southampton. Loudville, and 3 or 4 miles south.

A. Nash: Lead mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 249.

1835. **Galena.** In fetid limestone in West Springfield, at Paine's quarry.

E. Hitchcock: Geol. Mass., p. 230.

1838. **Galena.** Russell. Farm of John Gould. Norwich, farm of Quartus Angell.

E. Hitchcock: Econ. Geol., p. 127.

1841. **Galena.** Fourteen veins in vicinity of Connecticut River.

Adds nothing to preceding citations.

E. Hitchcock: Geol. Mass., final report, p. 199.

1844. **Galena.** (*Plumbites cubicus.*) Southampton. Leverett.

J. D. Dana: Sys. Min., p. 497.

1882. **Galenite.** Deerfield.

Extremely rare in minute grains in prehnite, chlorophæite, and calcite; in veins in diabase.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 351.

1883. **Galena.** Leverett.

East mine, in fine small cubes.

Whitaker, class of '83, Amherst College.

1895. **Galena.** Southampton lead mine.

Pseudomorph in quartz. Hollow cubes, with thin plates on the interior, which have penetrated the cubical cleavage of the galena.

GARNET.

1818. **Garnet.** Conway, Deerfield, Shelburne.

Melanite. Conway.

E. Hitchcock: Geology of Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

In a supplement it is said that above is probably not melanite; *ibid.*, p. 439.

1822. **Garnet.** Plainfield.

Mass as large as one's head entirely composed of garnets one-fourth inch diameter in hyaline quartz.

Dr. J. Porter: Editor's note; Am. Jour. Sci., 1st series, Vol. IV, p. 55.

1823. **Garnet.** Tolland, Plainfield, Chesterfield, Conway, Deerfield, Brimfield.

Tolland; nearly rose red (Webster). Plainfield, in limpid quartz, trapezohedrons black (J. Porter); in talcomicaceous slate, dodecahedrons brown-red, one-third inch in diameter, dodecahedrons with truncated edges, dull-red, two-fifths inch; also in dodecahedrons 2 inches in diameter in talcose slate. Chesterfield, with sappare, trapezohedrons, light rose-red. Conway and Deerfield, in hornblende and mica-slate, black dodecahedrons.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 222.

1823. **Pyrope.** Brimfield.

In granite, with light-green feldspar in rounded irregular masses of a delicate poppy red, much resembling some varieties of the ruby. "It scratches crystallized quartz," says Professor Dewey, "and melts rather hardly into a dark enamel; found in digging a well."

E. Hitchcock: Loc. cit.

1823. **Colophonite.** At Conway?

E. Hitchcock: Loc. cit., p. 222.

1824. **Garnet.** Hawley, Middlefield, Chester.

Hawley; large dodecahedrons. Middlefield; dodecahedrons, trapezohedrons, and the same with truncated edges.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 44.

1824. **Melanite.** Chester; in hornblende.

C. Dewey: *Ibid.*

1825. **Melanite.** Conway; in mica-slate.

Eaton: Index, p. 145; Robinson's Cat., p. 44.

1826. **Garnet.** Chesterfield.

Some rocks of reddish-brown hornblende contain an immense number of garnets from the size of a shot up to that of a small cannon ball. These rocks are situated a mile northeast of the meetinghouse, near the celebrated locality of cyanite.

J. Porter: Min. Not.; Am. Jour. Sci., Vol. IX, p. 18.

(This is the garnet-cumingtonite rock.)

1835. **Garnets.** Brimfield, Wales, Ware.

Very delicate garnets in Brimfield, in gneiss; also less fine in Wales and Ware.

E. Hitchcock: Geol. Mass., p. 398.

1841. **Garnet.** Westfield.

Massive in serpentine. Also summary of above citations.

E. Hitchcock: Geol. Mass., pp. 188, 606, 618.

1844. **Garnet.** (*Carbunculus dodecahedrus.*) Brimfield, Chesterfield, Cummington.

J. D. Dana: Sys. Min., p. 382.

1866. **Garnet.** Northfield, on Northfield Mountain.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

1886. **Garnet.** Northfield.

Fine deep-red garnets, almost suitable for cutting, occur in immense numbers on old Chapin farm on Northfield Mountain, five minutes' walk east of black lead mine; crystals nearly an inch across, 2 O 2 with striated faces, ∞ O.

1887. **Garnet.** Davis mine, Rowe.

Red-brown, 6 to 8 mm. across, ∞ O. Broad surface of pyrite and garnet, making attractive specimens.

1894. **Garnet. Almandite.** Goshen, etc.

The garnet characteristic of the Goshen and Conway schists, which has often been called melanite, is a common iron alumina garnet.

The crystals have a curious and beautiful structure when seen in thin section. Commencing at the center, six radial bands of quartz grains extend outward in the clear material, and the latter becomes gradually clouded with a very fine dust, which increases to a maximum, and a clear band follows with beautiful bastion-like outgrowths at the corners. (See fig. 1, showing garnet with quartz enclosures and clear rim from secondary enlargement, from Conway schist, Hawk's quarry, Goshen.)

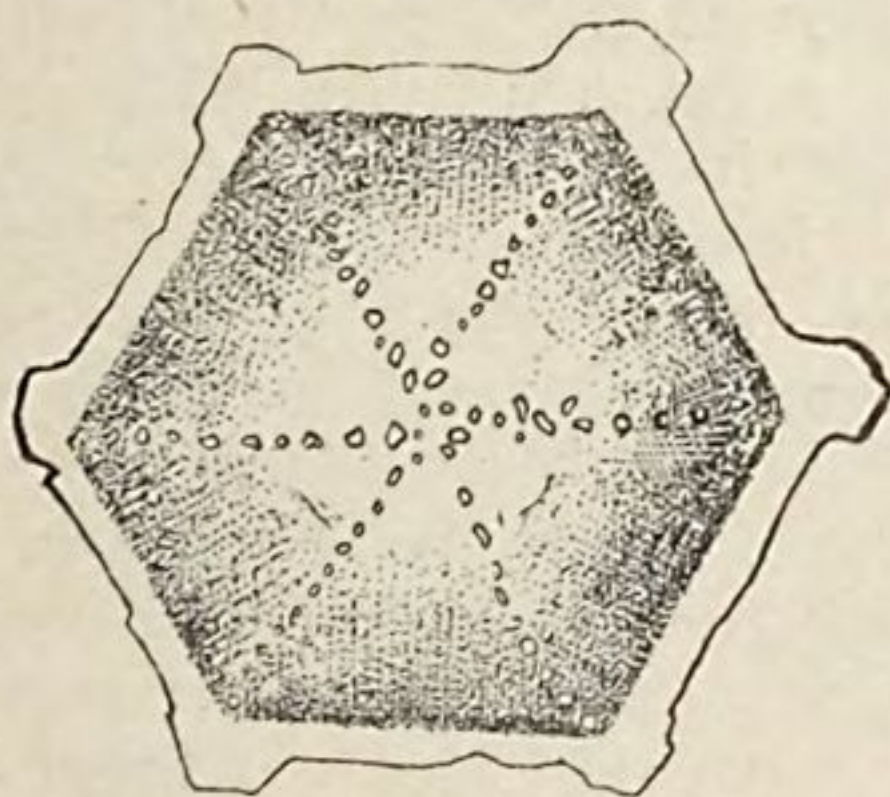


Fig. 1.—Garnet with quartz inclosures.

An analysis was made by Mr. George Steiger, of the United States Geological Survey, of material selected from a typical specimen of the Conway schist coarsely spangled with transverse biotites from the northwestern part of Goshen.

Analysis.

SiO ₂	37.30
TiO ₂	.24
Al ₂ O ₃	21.84
Fe ₂ O ₃	.98
FeO	32.62
MnO	1.86
CaO	3.19
MgO	2.50
	100.53

1894. **Garnet.** Warwick.

On south road to Warwick, at last house but one before reaching town line; crystals quite good and abundant in mica-schist, ∞ O, 2 O 2, 9 mm. in diameter. Also on North Mountain, three-fourths mile east of Horace Sykes's; crystals deep-red and of perfect form, ∞ O, 2 O 2, 25 mm. in diameter.

Warwick, at D. Bacon's, northwest of town, ∞ O up to 10 mm.; fine crystals in mica-schist.

1894. **Garnet.**

Chester, at the "quartz mine" in the extreme east of the town, 2 O 2; 30 mm. in diameter, fine dark-red near center; large and fine, like the Russell crystals.

1894. **Garnet.** Russell.

One mile south of Thorp's, now Pomeroy's, the first house on the river road coming from Westfield, perfect forms 2 O 2, abundant and very large black almandine garnets from a granite vein. This locality has been largely worked by Mr. Daniel Clark and by a Mr. Johnson, of Tyringham, and specimens from this locality, most ingeniously fabricated, have been offered for sale as coming from Tyringham. Many hundred dollars' worth were obtained from the locality, which is now exhausted. They have been also cited as coming from Westfield.

1894. **Garnet.**

Huntington, 2 O 2 in granite, 75 mm. across.

1895. **Garnet.** Northfield.

C. A. Ware's pasture, Gulf road; boulder of coarse muscovite granite.

Red almandine garnets with exceptional dodecahedral cleavage, of the form 2 O 2, three-fourths inch across, with a kelyphite-like rim three-sixteenths inch wide, but with irregular outer border, which is opaque white, but appears finely plumose with a lens. A narrow dark-green border can be seen to separate the white rim from the garnet.

Under the microscope the garnet is seen to have a very irregular surface, and a layer of zoisite and hematite fits into all the irregularities and builds out quite perfect crystal faces for the garnet. The hematite is in parallel bands in distant partings in the zoisite, and round blebs of this are inclosed with quartz grains in the clear garnet.

Outside this is a second thin layer of a green chlorite, and the series is closed by a broad and beautifully plumose and tufted growth of fibrolite in the finest fibers, which grows out into the feldspar and quartz of the surrounding granite.

GEDRITE.

1892. **Gedrite.** (Aluminous anthophyllite.) Warwick.

On the hill 20 rods south of Harris's soapstone quarry. A very coarse, granular, rich hair-brown rock. The separate plates show fine cleavage parallel to the prism and pinacoids. Under the microscope a part of the color is found to be due to the deep red-brown rutile grains and rods, which often are geniculate crystals.

The mineral shows moderate pleochroism; *a* almost colorless; *b* clove brown; *c* pale clove brown. Transverse sections, showing strong cleavage of 124° , gave the ring system symmetrical to *c* and the plane of the optical axes parallel to *b*. It is optically negative.

Delicate needles, long and rigidly straight and parallel, occur now and then in some number parallel to *c* and *b*. The mineral is very fresh, and will furnish fine cabinet specimens in great quantity. The large soapstone deposit to the north is formed by its decomposition.

The following analysis (I) was made with very fresh material, separated by heavy solution, in the laboratory of the Survey, by Mr. E. A. Schneider. II was of the average rock, by L. G. Eakins.

	I.	II.		I.	II.
SiO ₂	47.86	50.65	K ₂ O	.06	.04
TiO ₂ *	.63	.50	Na ₂ O	.93	1.37
Al ₂ O ₃	14.09	13.03	H ₂ O (105°)	None.	.....
Cr ₂ O ₃ .....	.....	Trace.	H ₂ O (above 105°)	2.46	†2.96
Fe ₂ O ₃	.33	.27	P ₂ O ₅	.05	Trace.
FeO	13.41	12.67	B ₂ O ₃ .....	.....	.....
MnO	.14	.15			
MgO	19.89	16.96		100.42	100.33
CaO	.57	1.73			

* Total 7; O₂ in the form of rutile.

† Direct determination.

GOETHITE.

1852. **Goethite.** Greenfield, near Turners Falls.

In powdery scales along with the chalcopyrite in a thin vein at the junction of the sandstone and trap.

C. U. Shepard: Min., p. 278.

GOLD.

1833. **Gold.**

E. Hitchcock: Geol. Mass.; Am. Jour. Sci., 1st series, Vol. XXII, p. 65; Separate publication, Amherst, Mass., p. 65.

The probability of finding gold in the sericite-schist is fully discussed and an account is given of its being found in his presence at Somerset, Vt., just over the State line; twenty or thirty pieces, in weight 7 grains. He indicates the neighborhood of the Hawley iron mine or the Plainfield manganese bed or the bed of the Deerfield River, in Monroe, or Charlemont, as probable localities.

1841. **Gold.**

I have received many reports of the washing of gold in the western hills, but have never seen any derived from any portion of the three river counties, nor does President Hitchcock seem to have been more fortunate. He gives a long list of foolish attempts to find the precious metal.

Geol. Mass., 1841, p. 612.

1879. **Gold.** Chester.

"Specimens of gold and silver are said to have been found" in Chester. Hist. Conn. Valley, Vol. II, p. 1054.

1886. **Gold.** West Worthington.

[From the Hampshire Gazette, February 22, 1886.]

WEST WORTHINGTON, *January 25, 1886.*

To the Editor of the Hampshire Gazette:

Prof. Edward Hitchcock, a former president of Amherst, was an eminent geologist, as is very well known from his different works on the science, and he was many years ago employed to make a geological survey and report of the State of Massachusetts. He found the lone, long, narrow streak of talcose slate formation, but did not stop, it seems, to look it over carefully to see what it contained. He left that for others to do.

I will premise "that these talcose rocks are to a great extent the gold rocks of the world, especially the quartz veins therein." So states Professor Dana in his Mineralogy. The comparatively narrow strip of talcose slate ledge starts at the south end including Chester, extends north to Vermont State line in the town of Heath, where they are now mining for gold and copper. In my present brief description of this strip of talcose ledge, I shall confine myself to the two ends of a section about 3 miles in length, running in a north and south direction, in the towns of Worthington and Peru.

First, at the south end, on the farm of Austin Geer, of West Worthington, are two large quartz veins, one white and the other yellow in color. They run parallel with each other, about 20 rods apart. They crop out of the slate rock, 6 rods in length each, and will average about 2 feet in width. These two veins are thickly filled from the surface down with very beautiful, shining crystallized sulphurets of various-sized cubes of gold, silver, and manganese, or alabandine. Native gold, or a nugget as large as a common-sized pea, has also been found here.

1886. **Gold**—Continued.

Second, at the north end of this limited strip of slate ledge, on the farm of Wesley Pierce, of Peru, occurs a very remarkable open surface bed of rich gold and silver, that has yielded, from fair crucible tests, over \$100 to the ton of ore, of both gold and silver.

CHAUNCEY STEPHENSON.

The above letter is copied as an illustration of the basis upon which mining work is still often done in Massachusetts. It is not probable that the writer obtained anything from the region excepting pyrite.

1887. **Gold**. Buckland.

"Gold mine" at house of H. W. Dodge. A thin pyritous hornblende bed in the Conway schist.

I copy the following remarkable papers as another illustration of the manner in which people are still led to waste money on the foolish search for gold:

[W. French Smith, Ph. D. (consultation), State assayer and analyst for Massachusetts; A. B. Brown, assayer and analyst. Certificate of analysis, 7509.]

In 2,000 pounds.

0.25 ounce Troy gold, at \$20.67.....	\$5.17
1.14 ounces Troy silver, at \$1	1.14
0.00 ounce Troy copper, at 11 cents	0.00
5 ounces Troy lead, at 5 cents.....	.25
	6.56

January 6, 1887. 235 Washington street, Boston.

[Established 1853. Gold and Silver Refining and Smelting Works of L. B. Darling, Providence, R. I.]

THEODORE WOOD, Esq.,

Shelburne Falls, Mass.

DEAR SIR: The specimens of rock sent me by express give good indications outwardly of containing gold and silver. I have assayed many specimens [sic!] giving less indications and yet good results in the precious metals. The costs of assaying and giving you the real results in value per ton will be \$3.

Yours, truly,

L. B. DARLING.

MARCH 2, 1887.

[Assay 4218. Drab slaty mineral with iron pyrites.]

Gold per ton, 1 ounce; silver per ton, 2½ ounces; value, \$23.90.

[Assay 4564. Dark-blue slate rock with pyrites of iron.]

Gold per 2,000 pounds, four-tenths ounce; silver per 2,000 pounds, one-fifth ounce; value, \$8.44.

L. B. DARLING.

A button of the gold obtained from this mine was said to be on exhibition at Mr. Henry Swan's, in Shelburne. It would be hard to find a ledge in the region which showed any less "indications" of gold.

GRAPHITE.

1820. **Plumbago**. Brimfield.

In granite and gneiss.

A. Eaton: Index, p. 94.

1823. **Plumbago.** Cummington, Worthington, Chester.

Foliated.

J. Porter: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VI, p. 248.

1826. **Graphite.** Same.

Ibid., Vol. X, p. 18.

1835. **Graphite.** Same.

E. Hitchcock: Geol. Mass., p. 347.

1838. **Molybdenite.** Brimfield.

In granite with salite.

J. W. Foster; Am. Jour. Sci., 1st series, Vol. XXIII, p. 399.

1841. **Graphite.** Same.

E. Hitchcock: Geol. Mass., final report, p. 607.

1866. **Graphite.** Northfield.

"Black-lead mine" on land of Mr. Piper. A highly plumbaginous mica-schist.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

(This occurs one-half mile south of Mr. F. W. Piper's house on the gulf road in Conway schist. Broad pieces 10 mm. thick of very pure graphite can be obtained, showing the finest slickensides or striation caused by the slipping of the mass under pressure. The coarse rich red-brown biotite, which is interfoliated with the graphite, is also much influenced by undergoing pressure on a yielding substratum. It is at times full of secondary cleavages or gliding planes, and at times drawn out into a straight fibrous form of great beauty. A broad plate has been sheared across by many planes at right angles to the base and then each of these rods has been crumpled into a coarse fiber.)

1876. **Graphite.** Leverett lead mine, south mine.

In a mass 1 by 1½ inches, finely slickensided, entangled with barite and quartz on side of 2-inch barite vein.

1885. **Graphite.**

Graphite occurs as coloring matter in the Conway and Goshen schists, across the State on the west side of the river, and in Northfield on the east side, and in shining scales in the garnet hornblende rock at "Pike's Peak," Prospect street, Amherst, and in the Brimfield schist along the eastern border of the three counties, and all the citations above refer to the unimportant occurrences of this character, except that from Brimfield, where the Brimfield graphitic fibrolite schist becomes locally a quite pure graphite schist, which was extensively mined for many years just east of Brimfield, in Sturbridge.

1886. **Graphite.** Charlemont.

Excavation has been made on a quite large bed of impure graphite, about 5 feet wide, about 40 rods northeast of the house of Joseph Tinkham, in the Hawley schist.

1895. **Graphite.** South Hadley.

At Larrabee's quarry quite large scales of graphite occur in considerable abundance upon the surface of the layers of sandstone. They must have been carried across the bottom of the Triassic bay from near Wilbraham and have been derived by the streams from the region about Brimfield.

GYPSUM.

1823. **Gypsum.** Deerfield.

In amygdaloidal greenstone in Deerfield in small quantities; white and retaining its water of crystallization. Found by Dr. Cooley and determined by Professor Silliman.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 212.

1826. **Sulphate of lime** (Gypsum).

In layers in slate in West Springfield, like fish-scales, one-half inch in diameter.

E. Davis: Rocks and minerals of Westfield; *ibid.*, Vol. X, p. 215.

1835. **Gypsum.** West Springfield and South Hadley.

Minute quantity.

E. Hitchcock: Geol. Mass., p. 209.

1859. "**Moulds of organisms.**" South Hadley Falls.

E. Hitchcock: Cat. of State collection; Rep. of Board of Agriculture, p. xxi, No. 154.

On examining the specimen in the Survey collection I find there are very flat prismatic cavities often nearly an inch across and resembling exactly the shapes very commonly taken by gypsum crystallizing in clay. They occur in a red argillaceous shale. I have found the same forms at the railroad cut near the dam in Holyoke.

1882. **Selenite.** Deerfield.

Professor Hitchcock mentions that selenite had been found in the Deerfield trap by Professor Silliman (Am. Jour. Sci., 1st series, Vol. V, p. 212), and described molds of unknown crystals left in the quartz of the zeolitic veins east of Deerfield. Casts taken from these molds show that the mineral which has disappeared was selenite, which occurred here very abundantly and in well-formed crystals 20 mm. long. The quartz rises into the molds in sharp parallel crests where it had penetrated between the laminae of the selenite along the perfect cleavage.

In the Cheapside veins similar but smaller negative crystals occur in the prehnite which at times rose around and covered the selenite before its disappearance, forming thus rude pseudomorphs; and I suspect that part or all of the abundant gasping of the prehnite, quartz, and datolite may be due to this mineral.

B. K. Emerson: Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 351.

1891. **Gypsum.** Delaney's quarry, Northampton, near Holyoke north line.

Surfaces of the trap are covered with pyrite. Above this is a thick layer of calcite slashed by deep cavities 27 mm. long by 3 mm. wide, which are the casts of crystals that have disappeared. The bottom of the cavity is ribbed, as is often the case with gypsum crystals, and such have probably occupied the cavities.

The finding of anhydrite in the trap at Delaney's quarry strengthens the probability of the above interpretation of the negative crystals of the trap.

HALOTRICHITE.

1876. **Halotrichite.** Bernardston.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 2.

(I know nothing of this mineral. Any specimens which may have existed were probably destroyed in the burning of the Shepard cabinet.)

HAMPSHIRITE.

1822. "**Crystallized steatite.**" Middlefield.

"This rare mineral was found by Dr. E. Emmons. * * * The crystals usually occur in groups on masses of steatite. On a piece 3 inches long and 2 inches broad are more than 40 crystals. Some are three-eighths of an inch in diameter and more than half an inch in length. I have one which is double the dimensions just mentioned.

"The surface of the crystals is of a brown color, produced by the action of the weather; but when the crystals are separated their faces are of a yellowish-white color; when fractured, the crystals present an uneven surface, with a structure inclined to the fibrous. The same fibrous appearance is seen on some parts of the steatite—which is destitute of crystals.

"The crystalline structure is exceedingly indistinct, except near the surface. The predominant form of the crystal is a six-sided prism, terminated at one or both extremities by a pyramid of the same number of sides. The truncations are numerous; sometimes on the edges of the prisms or pyramids, and at others on the angles or at the vertex of the pyramid. * * * They very much resemble some quartz crystals."

Then follows an argument against their being pseudomorphs, which is directed against their being pseudomorphs by replacement, and the author concludes that they are crystallized steatite.

Prof. C. Dewey: Am. Jour. Sci., 1st series, Vol. IV, p. 274.

1822. **Crystallized steatite.** Middlefield.

"I have lately visited the locality of this mineral. It is found in the great bed of serpentine in Middlefield; * * * only in one place between two layers of serpentine; * * * in steatite, 2 or 3 inches thick, the upper surface of which is covered with these crystals. The crystals are, however, separated from the superincumbent mass of serpentine by a thin layer of asbestos (chrysotile) pressed down entirely close upon the crystals, and if it be carefully removed from them shows the form of the heads of the crystals.

Prof. C. Dewey: Ibid., Vol. V, p. 249.

1823. **Crystallized steatite.***Analysis.*

H ₂ O	15.00
SiO ₂	50.60
Fe ₂ O ₃	2.59
MgO	28.83
MnO ₂	1.10
Al ₂ O ₃	.15
Loss	1.73
	100.00

Sp. gr. 2.

C. Dewey: Am. Jour. Sci., 1st series, Vol. VI, p. 333.

1825. **Crystallized steatite.**

Above cited.

C. Dewey: Geol. of part of Mass., *ibid.*, Vol. VIII, p. 51.

1835. **Steatite after quartz.**

President Hitchcock cites the discoverer, Dr. Emmons, as believing that these crystals are those of steatite, but, without expressing a definite opinion, seems to believe that they are after quartz, with which, he says, they correspond exactly.

E. Hitchcock: Geol. Mass., 1835, p. 377.

1843. **Steatite after quartz.** Middlefield.

Blum cites the above from Hitchcock, and does not hesitate to class the occurrence as a pseudomorph of steatite after quartz.

Pseudomorphosen, p. 124.

1852. **Saponite.** Middlefield.

Hampshirite (Hermann) quoted as a synonym.

In serpentine and as pseudomorphs copying crystals of quartz. (I can not learn where the name was published by Hermann.)

C. U. Shepard: Treatise on Min., p. 151.

1868. **Aphrodite** (subspecies); Hampshirite. No locality.

Its purity and individuality as a species doubted.

J. D. Dana: Sys. Min., p. 457.

1887. **Hampshirite.** Chester. (See Pl. I, fig. 4.)

There is in the Clark collection, now in Smith College, a unique and remarkable specimen, with this curious label: "Hampshirite; steatitic pseudomorphs after quartz; Chester, Mass., on the road to Middlefield. Locality exhausted and filled up with rocks to prevent anything more being taken from it. Bailey thinks this specimen could not be duplicated. From Rowe's collection. He procured it at the locality for \$10.00."

This label is in Mr. James Clark's handwriting. The piece is so interesting that I have figured it in Plate I, D.

It proves to be a pseudomorph after olivine, and to follow quite closely the type figured by Des Cloizeaux. Man. Min. Atlas, Vol. VII, p. 41, from Torre del Greco, showing the faces ∞P (110), $2 P \propto$ (021), $4 P \propto$ (041), $\infty P \propto$ (010), P (111). ∞P measured $129^{\circ} 30'$ to $131^{\circ} 30'$; true angle, $130^{\circ} 2'$. $2 P \propto = 79^{\circ}$ to $81^{\circ} 30'$; true angle, $80^{\circ} 53'$. The crystals are in stout prisms up to 4 cm. long; brownish-yellow, and covered in large part by a secondary deposit of a compact fibrous greenish-white chrysotile, sp. gr. 2.24.

The discrepancy in the localities of the "crystallized serpentine" above and the "hampshirite" arise from the fact that the great serpentine mass extends into both towns. They both refer to the same locality. There were fine specimens in the Shepard collection. With the exception of these crystals, I have never been able to detect any trace of olivine by a careful microscopical study of every serpentine outcrop on the west side of the river. Mr. M. E. Wadsworth cites a peridotite from the Westfield River, but says the olivine structure is wholly gone, and his figure shows only the square-meshed enstatite structure. (Lithological Studies, Pl. 7, p. 2.) As indicated above, the locality is now lost.

1892. **Hampshirite.** No locality.

The data given in 1868 are cited without essential change. "Probably not homogeneous."

E. S. Dana: Sys. Min., p. 675.

HEMATITE.

1818. **Specular oxide of iron.** Hawley, Bernardston, Warwick.

Veins wrought to some extent.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 115.

1819. **Specular oxide of iron.** Montague.

"In a detached eminence 100 feet high on land of Mr. Taft, near mouth of Millers River. The whole hill traversed by numerous veins, and scarcely a foot of the rock is to be found which does not contain them, varying in width from a mere line to several inches. The principal vein appears on

1819. **Specular oxide of iron**—Continued.

the top of the hill, and is, as nearly as I could determine, not less than 10 feet wide, lying in a north and south direction. Ore abundant and generally pure. Masses that have been separated by blasting and weighing 100 to 200 pounds lie on the surface; pyrite present; the gangue is quartz. The walls and hill are composed of granite."

E. Hitchcock: Sup. Geol. Deerfield; *ibid.*, p. 438.

1822. **Micaceous oxide of iron.** Hawley.

"Of extreme beauty; is found a few miles from Northampton. It has high luster and is contorted with delicate flexing, as if it had lain between the layers of mica-slate, which we presume must have been the fact. Dr. Hunt and Mr. W. C. Dwight, of Northampton, have favored us with specimens, and similar ones from Hawley, in Massachusetts, have been transmitted by Dr. Jacob Porter, of Plainfield; this last is particularly beautiful and is sprinkled with points of magnetic iron."

Editor's note: Am. Jour. Sci., 1st series, Vol. IV, p. 53. (Both parts of this note refer to the same locality.)

1823. **Specular oxide of iron.** Same.

Ibid., Vol. VI, p. 207.

1823. **Micaceous oxide of iron.** Bernardston.

With magnetite, like Hawley, in "talco-argillite."

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 208.

1823. **Micaceous oxide of iron.** Hawley.

Northwest part of town in talcose slate; the principal bed of the ore varies from 6 inches to 3 or 4 feet thick. Mine opened 20 or 30 rods long, 30 or 40 feet deep. Magnetic oxide most abundant; the micaceous oxide not wrought, from the belief that it would not smelt.

Ibid.

1825. **Hematite?** Vitreous black oxide of iron.

Southampton lead mine, in carbonate of lead. Before blowpipe infusible, becomes magnetic.

C. U. Shepard: Min. Loc.; Am. Jour. Sci., 1st series, Vol. IX, p. 47.

1825. **Micaceous iron.** Northampton (misquotation of 1822 above for Hawley).

High luster, contorted (Cleaveland.) Warwick; wrought to small extent (Am. Jour. Sci., 1st series, Vol. I, p. 115).

Robinson's Cat., p. 64.

1827. **Hematite.** Hawley, at junction of mica and talcose slate.

A. Nash: Lead mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 245.

1841. **Micaceous specular iron ore.** Hawley.

Formerly rejected as worthless, but is an exceedingly rich ore.

Analysis.

Fe ₂ O ₃	99.26
H ₂ O	.60
Loss.....	.14
	100.00

Also Montague.

E. Hitchcock: Geol. Mass., p. 196.

1879. Hematite. Hawley.

West of the Center is a hill containing a rich deposit of iron ore which was mined about 1800 to supply a furnace near by, and which gave the name of "Forge Hill" to this locality.

Hist. Conn. Valley, Vol. II, p. 704.

1885. Hematite.

In minute spheres with concentric structure superficially embedded in quartz crystals, so as always to fill the same half of the surface of each crystal, as if the solution had dripped down a vertical fissure, which was covered with the growing quartz crystals. In diabase south of Titan's Piazza.

Discovered by Prof. J. M. Clarke.

1886. Hematite. Hawley.

The fine micaceous ore is a bed intercalated in the schists adjacent to a fault, and the mineral may be regarded as a pseudomorph by replacement of muscovite. It is for the most part a quartz-hematite schist or itabirite, of which the texture is exactly like that of the adjoining mica-schists, with which it is conformable, only that the mica is replaced by the scales of specular iron. It is interesting to note that a similar replacement of biotite by specular iron occurs among the minerals formed by the partial melting of the olivine-rock inclosures in basalt.¹

In the case before us I think it probable that heated waters occupying the fissure, and borrowing iron from the adjoining ankerite, have replaced the mica along the sides of the opening.

1891. Hematite. South of Northampton.

Quarry in sandstone beside Connecticut River Railroad, at north line of Holyoke.

Fine broad layers 3 mm. thick with botryoidal and drusy surface made of shining plates set edgewise in fissure in brown stone. These plates are formed by the large development of the plane 0. It also impregnates the sandstone. In both cases it is just above diabase, which gives every indication of having been so quickly covered that the heat of the mass greatly quickened the circulation and increased the chemical activity of the solutions which permeated the covering of sand, cementing it and filling its fissures with the hematite.

HERMANNITE.

See Rhodonite.

HEULANDITE.**1825. Heulandite.** Chester.

"In the cabinet of Dr. Emmons in Chester I was shown specimens of a mineral considered as stilbite, which I at once recognized to be heulandite crystals about one-eighth inch long. Locality exhausted."

C. U. Shepard: Bost. Jour. Phil., Vol. III, p. 608.

1825. Heulandite. Chester.

Right oblique prism, acute edges replaced; white; with chabasie and stilbite in mica slate.

E. Emmons: Min. Not., Am. Jour. Sci., 1st series, Vol. X, p. 11.

¹ K. Bleibtreu: Zur Kenntniss der Einschlüsse in den Basalten; Zeitschrift der deutschen geol. Gesellschaft, Vol. XXXV, p. 546.

1831. **Lincolnite.** (Hitchcock.) Deerfield.

Full description, figure, and measurements; named after the then governor, Lincoln. From trap of Deerfield Mountain, east of village.

E. Hitchcock: Geol. Mass., p. 437.

1841. **Lincolnite.** In trap, 1 mile east of Deerfield.

Description, figures, and measurements.

Ibid., p. 662.

1843. **Heulandite.**

Declaring the lincolnite to be heulandite and $M > T$ to be 130° .

F. Alger: Proc. Bost. Soc. Nat. Hist., Vol. I, p. 145 (abstract); Bost. Jour. Nat. Hist., Vol. IV, p. 245; also Am. Jour. Sci., 1st series, Vol. XLVI, p. 233.

1844. **Heulandite.** (*Zeolus rhomboideus*.) Deerfield. Chester.

J. D. Dana: Sys. Min., p. 324.

1844. **Lincolnite.**

Wishes an arrest of judgment concerning the identity of lincolnite and heulandite, and states that the crystals sent to Mr. Alger were from a second and later find, a few rods from the first; gives a later measurement of Professor Shepard as $116^\circ 45'$ to $117^\circ 15'$.

[Editor's note: The angle measured is not the primary lateral angle $130^\circ 30'$, but the angle of $T(0)$ on $\tilde{\epsilon}(2-i) = 115^\circ 10'.$]

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. XLVII, p. 416.

1844. **Heulandite.**

Lincolnite is heulandite.

F. Alger: Alger's Phillips Min., p. 37.

1845. **Lincolnite.**

Professor Shepard defends the species and gives a new series of measurements, obtaining $117^\circ 08' 06''$; to which B. Silliman, jr., in a note, rejoins that if the new measurements given by Professor Shepard in the above note be correct the corresponding angle of H would be $116^\circ 17'$.

Am. Jour. Sci., 1st series, Vol. XLVIII, pp. 175, 179.

1845. **Lincolnite.**

Thinks that the modifying plane suggested in the note of the editor appended to last paper does not settle the question, "for the modifying plane mentioned occurs rarely, as it is extremely narrow, and it could not be confounded with the primary plane by so practiced an observer as Professor Shepard."

Mr. Teschemacher informs him that he did not know he was measuring the lincolnite, and so gave it no special care, and does not wish to be quoted as asserting the identity.

[Editor's note: The plane $\tilde{\epsilon}$ enlarged may obliterate M , one of the primary faces, or nearly obliterate it, and then the narrow plane left would be the one alluded to above.]

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. XLVIII, p. 64.

1846. **Lincolnite.**

Peculiarities in the modifying planes have given rise to a secondary form rarely observed in heulandite. These consist in the enlargement of the planes f (Phillips) or $\tilde{\epsilon}$ (Dana), so as nearly to obliterate the planes M , being in fact the reverse that we observe in heulandite from other localities.

In the measurements by Professor Hitchcock and Professor Shepard the angle of f on T was mistaken for M on T , and in the figure given by Professor Hitchcock it is evident that the plane lettered M should be f .

1846. **Lincolnite**—Continued.

The true value of f on T is $115^{\circ} 10'$ (Dana). Professor Shepard's last measurement made is $116^{\circ} 17'$.

F. Alger: Loc. of rare min.; Post. Jour. Nat. Hist., Vol. V, p. 306.; Proc. Bost. Soc. Nat. Hist., Vol. II, p. 89 (abstract).

1852. **Heulandite**. "Lincolnite (heulandite) belongs here."

C. U. Shepard: Min., 3d ed., p. 163.

1876. **Lincolnine**. Deerfield.

C. U. Shepard: Cat. Min. 75 miles of Amherst College, p. 4.

Given in accordance with his suggestion to use "ine" for minerals whose specific character is not fully settled, a suggestion which has not been anywhere adopted.

1880. **Heulandite**. Amherst.

At Pikes Peak, a small projecting rock at the north end of Prospect street, now blasted away for the foundation of a house, in a quartz-garnet-hornblende rock, beautiful brick-red crystals (P, M, T, N, z) 3 mm. long, tabular on M, and in drusy crystalline surfaces, on fissures with very fresh pyrite, plainly of very recent development.

1882. **Heulandite**. Deerfield.

This mineral occurs quite abundantly at the new cutting in small, stout prisms, $i-i$, $2-i$, $-2i$, up to 2 mm. in length, with sharp edges and no indication of other faces. It is the lincolnite of President Hitchcock, and the specimens studied by me agree exactly with those labeled lincolnite by him, and coming from the old locality east of Deerfield. The mineral collection at Amherst contained a few crystals also identical with the above, from the Fitchburg railroad cutting, and these were separated by Professor Shepard from heulandite under the name lincolnite.

After careful study I find all these crystals identical with each other and with heulandite, both optically and crystallographically.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 357.

HORNBLLENDE.

See Amphibole.

HUMOFERRITE.

1876. **Humoferrite**. (Shepard. See Limonite, 1876.)

An unused synonym.

ILMENITE.

See Menaccanite, 1846.

INDIANITE.

See Oligoclase, 1865.

ISERINE.

See Menaccanite, 1835.

JEFFERISITE.

1870. **Vermiculite** or **Jeffersite**. Pelham.

Irregular veins separated by a decomposed asbestos, an altered mica; $H. = 1.5$; luster pearly, sometimes metallic; exfoliates, fuses on edges; shows six-rayed asterism.

J. H. Adams, class of '70, Amherst College; Am. Jour. Sci., 2d series, Vol. XLIX, p. 271.

1870. **Vermiculite?** Pelham.

Loses 7 per cent by ignition; 50 per cent dissolved in aqua regia, leaving white scales resembling margaric acid. They are so remarkable for their uniformity of size, freedom from color, and pearly luster as scarcely to suggest their inorganic composition. Under the microscope, however, they give very nearly the distinct lateral cleavage line of mica. Nor have they the perfect elasticity of a true mica. They show no tendency to further exfoliation when heated. Before the blowpipe they melt with difficulty on the edges into a colorless glass. Professor Des Cloizeaux was kind enough to examine some of these scales optically and found them to be uniaxial; the exfoliation caused by the coating of the mica scales with a hydrated argillaceous mixture, which probably owes its origin to the decomposition of some other member of the micaceous or chloritic family.

Al ₂ O ₃	14.00
MgO	13.68
Fe ₂ O ₃	32.00
Si ₂ O ₃	24.00
Alk(?)	(?)

C. U. Shepard: Min. Contrib.; *ibid.*, Vol. L, p. 96.

(Prof. L. Mears found the margaric acid-like scales obtained by boiling the above vermiculite in aqua regia to dissolve in K₂O, hence they are SiO₂.)

1875. **Pelhamite.** Pelham.

Full description and analysis.

J. P. Cooke, jr.: On the new varieties of vermiculites; *Proc. Am. Acad. Arts Sci.*, Vol. X, p. 453, Boston.

1891. **Jefferisite.** Pelham.

New excavations have produced crystals 4 inches square and nearly an inch thick, exactly like those from Westchester, Pa. They are a rich bronze-brown, often bent. They are derived from the biotite which surrounds the olivine rock.

KAOLINITE.

1823. **Porcelain clay.** Plainfield (Silliman), Conway, and Leyden, in small quantities.

E. Hitchcock: *Geol. Conn. River*; *Am. Jour. Sci.*, 1st series, Vol. VI, p. 229.

1827. **Kaolin.** Williamsburg; of superior quality. Conway.

A. Nash: Lead mines of Hampshire County; *ibid.*, Vol. XII, p. 261.

(The first may be the infusorial marl recently patented by a man in Williamsburg as a filling for piano frames.)

1831. **Porcelain clay.** Norwich, at lead mine.*Analysis.*

H ₂ O	8.00
SiO ₂	53.40
Al ₂ O ₃	36.26
CaO	.24
MgO	.68
MnO	.20
	98.88

E. Hitchcock: *Economic Geol.*, p. 130.

1880. **Kaolinite.** Amherst.

Well at northwest corner of College Grove.

Green, soft lithomarge from decomposition of orthoclase, muscovite, and fibrolite of coarse granite, and forming pseudomorphs of these minerals. It represents the surface of the granite which has been rotted beneath the Triassic sandstones, now newly exposed by glacial erosion.

Analyses made in the laboratory of Amherst College.

	No. 1.	No. 2.	No. 3.
SiO ₂	46.96	44.39	46.50
Al ₂ O ₃	28.01	33.54	} 35.62
Fe ₂ O ₃	3.14	2.13	
MgO.....	3.58	6.41	
K ₂ O.....	.....	.....	2.59
H ₂ O.....	11.14	12.60	11.57
	92.83	99.07	100.82

1882. **Kaolinite.** Deerfield.

"Along the shore in Greenfield, opposite Turners Falls, and especially on the new road between these towns, the nodules of the radiated prehnite are in whole or part changed into a white kaolin (?), the change uniformly commencing from the different centers of radiation and proceeding regularly outward. Under the microscope the kaolin-like material separates into opaque granules so extremely minute that they show in water the Brownian movement with wonderful perfection."

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 349.

1883. **Kaolinite after garnet.** Bernardston.

In the Leyden argillite, on the north line of Bernardston, minute garnets have been changed to a mass of soft clay, which still fills the cavities.

1888. **Kaolinite.**

The thin laminated clays of Champlain age which rest directly on the till in the Connecticut River valley and those of the Brimfield Lake will be described in full in the monograph on the geology of the region. They are extensively worked for brick in Turners Falls, Greenfield, Northampton, Amherst, Holyoke, Chicopee, South Hadley, Springfield, and Brimfield.

1890. **Kaolinite.** Blandford.

Extensive works have been erected by the Blandford Brick and Tile Company in Russell to work a deposit of clay found in Blandford many years ago by Mr. G. L. Twitchell.

"Sworn analyses by chemists of the Massachusetts Institute of Technology show the existence of a bed of kaolin * * * of the most valuable sort and in a quantity that is known to exceed 80,000 tons. * * * A comparative analysis shows that the Blandford clay is superior to the Mount Savage clay, the only American basis for fire brick that is worthy of notice, and even to the Sturbridge clay from England and the Chinese kaolin. Its finer strain makes a brick of the purest white."

Springfield Republican, December 6, 1890.

1890. **Kaolinite.** Blandford.

Situated just east of the village and due to the preglacial decomposition in situ of veins of coarse feldspathic pegmatite.

Analysis.

[By Dr. L. M. Norton, Institute of Technology.]

SiO ₂	52.03
Al ₂ O ₃	31.76
H ₂ O	15.55
MgO	.54
Fe ₂ O ₃	Trace.
CaO	Trace.
Alkalies	Trace.
	99.88

W. O. Crosby: The Kaolin in Blandford, Mass.; Technology Quarterly, Vol. III, p. 228.

KALINITE.

1818. **Native alum.** Leyden.

Efflorescing in small quantity on argillaceous slate.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. 1, p. 114.

1824. **Alum.** Ware, in mica-slate.

C. U. Shepard: Min. Loc.; *ibid.*, Vol. VIII, p. 235.

1825. **Alum.**

Conway, on mica-slate; Leyden, in carbonaceous clay; Ware, in mica-slate.

Robinson's Cat., pp. 45, 56, 73.

1835. **Alum.** Ware.

In gneiss.

E. Hitchcock: Geol. Mass., p. 398.

1841. **Alum.** Conway, northeast part.

Abundant.

Ibid., p. 604.

The pyritous Hawley schists and the rusty fibrolite Brimfield schist along the eastern border of the area show abundant white efflorescences of mixed iron and alumina sulphates.

KEROLITE.

See Bastite and Deweylite.

KILLINITE.

See Muscovite, 1879.

KNEBELITE.

1880. **Knebelite.** Plainfield.

There was in the Shepard collection (now burned) a specimen labeled by Professor Shepard "Tephroite, knebelite, Mg(Fe)SiO₂." It was dull yellowish-brown in color and of fibrous texture, apparently common hornblende.

LAUMONITE.

1835. **Laumonite.**

In amygdaloid in Massachusetts in small masses.

C. U. Shepard: Min., Part II, Vol. II, p. 3.

1835. **Laumonite.**

Doubts its occurrence.

E. Hitchcock: Geol. Mass., p. 436.

1841. **Laumonite.**

Not found in greenstone in Massachusetts.

E. Hitchcock: Geol. Mass., p. 662.

1876. **Laumonite.** Monson.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 4.

1882. **Laumonite.** Monson.

Large pieces of massive laumonite, white to pink, from Monson quarry. In a north-south fissure in the north end of the quarry the gneiss is much decomposed and the fissure filled with laumonite, massive, granular, and in quite large finely terminated crystals, ∞ P (110) — P ∞ (100), 26 mm. long, $1\frac{1}{2}$ mm. wide. The vein is permeated with bands of leek-green hornstone.

1886. **Laumonite.** Northampton. Quarry in granite south of W. N. Moore's, east of Florence.

Hollow pseudomorphs of albite after laumonite; fine drusy without and within, 10 mm. long ∞ P (110) — P ∞ (101). They rest on laumonite and quartz.

LAZULITE.

1893. **Lazulite.** Greenfield.

In 1892 Mr. C. C. Russell, of the class of 1894 in Amherst College, picked up in the bed of Hinsdale Brook a white vein-quartz boulder nearly 4 inches long and $2\frac{1}{2}$ inches square on cross section, having a glacial shape, smoothed on the four sides and rough on the ends, but later considerably waterworn. The half of one side is of deep azure blue of the shade of the Chrowder's Mountain lazulite and deeper than that of Grave's Mountain, Georgia. It is in squarish cross sections of imperfect crystals nearly half an inch across and the material extends a half inch into the mass.

The quartz is a clear, white, greasy, vein quartz, which has parallel to a plane of schistosity thin films of magnetite, and these graduate into films of a magnetite-muscovite-fibrolite schist. I am wholly at a loss to locate this schist in any region from which the ice could bring the boulder to this place, since fibrolite is wholly wanting in the rocks to the west and northwest across the Green Mountains, so far as I have examined them. The only other locality for lazulite in the United States is in Georgia.

LEPIDOLITE.

1835. **Lepidolite.**

"Dr. Emmons is of opinion that the 'large cleavable variety' of crystals occurs at Goshen. Probably he refers to the mineral that has generally been regarded as rose mica."

E. Hitchcock: Geol. Mass., p. 504.

This was doubtless muscovite.

1879. **Lepidolite.** Chesterfield, in cleavelandite.

A. A. Julien: Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 351.

LIMONITE.

1818. **Eagle stone, or nodular argillaceous oxide of iron.** Deerfield.

One specimen on banks of Deerfield River.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 116.

1819. **Bog iron ore.** Greenfield, Warwick.

E. Hitchcock: Sup. to Geol. Deerfield; *ibid.*, Vol. I, p. 436.

1823. **Nodular argillaceous oxide of iron.** Gill, near Falls, in dark hard slate of coal formation.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 233.

This refers to the abundant flattened egg-shaped concretions of pyrite changed to limonite found in the Triassic slate.

1827. **Iron bed; bog iron ore.** Williamsburg.

One-half mile below village, 30 rods south of Northampton road.

A. Nash: Lead mines, etc.; *ibid.*, Vol. XII, p. 258.

1832. **Limonite.** Greenfield, Northampton, Springfield, Williamsburg.

E. Hitchcock: Geol. Mass.; Am. Jour. Sci., 1st series, Vol. XXII, p. 55.

1835. **"Vitreous black oxide of iron."** Southampton lead mine.

E. Hitchcock: Geol. Mass., p. 507.

1835. **Limonite, nodular.** Gill, in slate of the coal formation.

C. U. Shepard: Min., 1st ed., Part II, Vol. II, p. 15.

(See 1823, above.)

1838. **Ocher.** Monroe.

No. 162 in State collection from Morton Ballou; formerly dug for paint; abandoned.

E. Hitchcock: Report on Economical Geol., p. 128.

1841. **Bog ore.** Warwick, Greenfield, Northampton, Springfield, Williamsburg.

E. Hitchcock: Geol. Mass., p. 198.

1852. **Limonite.** Gill, in slate of the coal formation.

C. U. Shepard: Min., 3d ed., p. 277.

1865. **Ocher and sienna.** East Whately.

Discovered and used above fifty years ago; is on land of Elihu Belden; called American sienna; used mixed with milk as a paint. Covers one-half acre 30 rods from Connecticut, in a long depression in the meadow extending from north to south. Is immediately below turf, 10 to 30 inches thick; rests on loam. Probably a spring deposit, very homogeneous and fine grained; ocher sienna-brown, and when ignited a red to burnt sienna.

Analysis.

	SiO ₂ .	Fe ₂ O ₃ .	Al ₂ O ₃ .	H ₂ O.	Total.
Deepest yellow.....	13.00	70.00	3.60	13.00	99.60
Do	20.00	63.30	5.00	11.70	100.00
Yellowish-brown.....	47.00	35.00	6.00	10.80	98.80
Brown.....	53.00	28.00	6.00	13.00	100.00
Pale yellow.....	63.00	17.50	7.00	12.50	100.00

Highly commended.

Report of Prof. Charles Upham Shepard's analysis of the East Whately ocher and sienna mine; Amherst, Mass., January 18, 1865.

1865. **American sienna.** Whately.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 2.

1876. **Humoferrite.** (Shepard.) Whately.

C. U. Shepard, Cat. of Min. within 75 miles of Amherst College.

"Its true character is that of a light river sediment highly charged with peroxide of iron, which ingredient forms one-sixth to three-fourths of its weight."

C. U. Shepard: Report Whately ocher and sienna mine, p. 4.

(Name not adopted.)

1876. **Melinine.** (Shepard.) Turners Falls.

C. U. Shepard: Ibid., p. 4. (See Limonite, 1823. The name has never been adopted.)

1879. **Bog iron.** Brimfield.

Formerly worked to considerable extent on farm of Charles Bugbee, since occupied by Michael Travers.

Hist. Conn. Valley, Vol. II, p. 994.

1891. **Limonite.** Bernardston.

Impregnates and replaces the limestone at Williams's farm in quite large amount.

1891. **Limonite after calcite.** Loudville lead mine.

Form ∞ P, — $\frac{1}{2}$ R, 5 mm. long; on quartz.

In Clark collection, Smith College.

LINARITE.

1891. **Linarite.** Manhan lead mine, Loudville.

In deep blue-bladed crystals in a cavity in quartz, determined by Professor Shepard. As there are only two small crystals known, no attempt was made to verify the occurrence. Color and form agree well with linarite.

Specimens in Amherst and Smith College collections.

LINCOLNITE.

1831. **Lincolnite.** See Heulandite.

MAGNETITE.

1818. **Iron sand.** Turners Falls, Montague side.

Considerable quantity.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 115.

1818. **Magnetic oxide.** Common west of the Connecticut River.

Ibid.

1822. **Magnetite.** Middlefield.

Octahedrons in mica-slate (Eaton).

Cleveland: Min., Vol. II, p. 596.

1823. **Magnetic oxide of iron.** Plainfield, Shelburne, Shutesbury, etc.

In small octahedrons in mica slate and gneiss. Hawley, in beds in talcose slate. Bernardston, in beds.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 232.

1824. **Magnetic oxide of iron.** Plainfield, Cummington.

Plainfield, cubic crystals in arenaceous quartz. Cummington, with cummingtonite (Dewey).

J. Porter: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VIII, p. 233.

1825. **Magnetite.** Zoar, Hawley.

Octahedra in chlorite.

Robinson's Cat., pp. 52, 78.

1825. **Magnetic oxide of iron.** Cummington.

J. Porter: Min. Loc.; Am. Jour. Sci., 1st series, Vol. IX, p. 55.

1826. **Magnetic oxide of iron.** Plainfield.

A small bed has lately been discovered.

J. Porter: Min. Not.; *ibid.*, Vol. X, p. 18.1826. **Magnetic iron.** Monson.

Abundant in gneiss.

S. Colton: Min. Not.; *ibid.*, p. 13.1833. **Magnetic oxide of iron.** Hawley.

Principal ore magnetic oxide; not abundant; bed rarely more than 1 to 2 feet wrought; now abandoned; owned by Hon. Samuel C. Allen. Appears 1 to 2 miles south and 2 to 3 miles north in Charlemont. (See Hematite.)

E. Hitchcock: Geol. Mass., p. 53.

1835. **Magnetic oxide of iron.** Blandford, Chester.

Octahedra in mica-slate.

Everywhere in the "chlorite slate."

Ibid., pp. 347, 363.1838. **Magnetite.** Warwick.

Probably the most extensive in the State. Attempt to work it abandoned because of impurity. No. 177 in State cabinet; from Alden Spooner.

Analysis.

Fe ₃ O ₄	66.4
MnO ₂	16.6
SiO ₂ , Al ₂ O ₃	17.0
	100.00

E. Hitchcock: Economic Geol., p. 124.

1841. **Magnetite.** Chester, Blandford, Warwick, Bernardston.

Chester. In talcose slate. The beds of magnetic oxide of iron in the west part of Chester, which are nearly a foot wide, occur in hornblende slate; but this appears to me to be interstratified with the talcose slate, so that probably the ore should be regarded as a continuation southerly of the beds in Hawley.

Blandford. Association not known.

Warwick. Near east line in mica-slate; at least two beds several feet wide; ore abundant, very compact; sp. gr. 4.47.

Analysis.

Fe ₂ O ₃	46.34
FeO	20.70
SiO ₂	15.28
MnO	7.92
MgO	4.18
CaO	4.88
Loss	.70
	100.00

1841. **Magnetite**—Continued.

Bernardston. Near the limestone.

Analysis.

Fe ₂ O ₃	57.86
FeO	29.98
SiO ₂	9.90
MgO	5.42
MnO	.54
Loss	.30
	100.00

E. Hitchcock: Geol. Mass., pp. 194, 612.

1841. **Magnetic oxide of iron.** Blandford, Chester.

Octahedra; in mica slate. Ibid., p. 607.

1841. **Magnetic oxide of iron.**

In chlorite slate; abundant; also more rarely in talcose slate.

E. Hitchcock: Ibid., p. 613.

1841. **Magnetic oxide of iron.**

In small disseminated masses in Shelburne in gneiss.

Ibid., p. 637.

1865. **Magnetite.** Chester.

Massive, thin-veined, granular, and disseminated. Massive variety perfectly pure and unmixed between the coarse-grained Lake Champlain ore and the fine-grained Swedish. In fracture slightly purplish tint, blacker than usual, free from pyrite and rust, no native magnets; magnetic with polarity. On top of North Mountain a continuous seam 10 to 15 inches wide in a chloritoidal vein 4 to 5 feet wide of disseminated magnetite; this forks off from the main vein on the east at 30° in talcose slate, sunk upon 25 feet. No emery; seen again 600 feet on; also on South Mountain 6 to 8 inches thick; has trace of titanium.

C. U. Shepard: Report Chester emery mine.

1886. **Magnetite.** Monson, Flint's quarry.

In broad sheets of muscovite in flattened reticulated bands, twinned after the octahedron, as at Liepersville, Pa., and almost rivaling it in beauty. From the pegmatite of the east wall of the quarry. Best specimens in Amherst College cabinet.

1891. **Magnetite.** Hawley.

This mineral is abundant the whole length of the vein on Forge Hill, replacing the better-known hematite in the bottom of the new shaft sunk at the old mine. It lies in a quartz vein in sericite schist.

1891. **Magnetite.** Plainfield, Charlemont.

Plainfield. Abundant in the continuation of the Hawley vein across this town, associated with rhodonite.

Charlemont. In a considerable vein in the south brow of the hill 1 mile north of village, and in fine octahedra in hornblende chlorite-schist near A. P. Maxwell's.

MALACHITE.

1818. **Green carbonate of copper.** Greenfield.

In greenstone vein on bank of the Connecticut River, passing under the river; not wrought.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 115.

1823. Green carbonate of copper. Greenfield.

Two veins considerably abundant; amorphous and earthy.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 231.

1881. Malachite. Leverett, Hatfield.

Occurs as coating and small tufts at new opening of Upper Leverett mine, and at Hatfield mine.

1888. Malachite. Loudville lead mine.

In layers 10 to 15 mm. thick and in fine tufted groups on chrysocolla; rare; finest specimens in Smith College and Amherst College collections.

1890. Malachite. Chester.

In hornblende schist in the shaft of the emery mine; broad films on cleavage planes. Especially abundant in a peculiar olive-green serpentine.

MANGAN-AMPHIBOL.

See Rhodonite.

MARCASITE.

1835. White iron pyrites. Cummington and Plainfield with cummingtonite.

C. U. Shepard: *Min.*, 1st ed., Vol. II, p. 159.

1841. White iron pyrites. Same.

E. Hitchcock: *Geol. Mass.*, p. 608.

1886. Marcasite. Cummington, Mass., and throughout western New England.

Massive and fibrous in mica-schist.

The pyrite of Charlemont is cited as pyrrhotite and pyrite, that of Rowe as pyrite.

A. A. Julien: Decomposition of iron pyrites; *Ann. N. Y. Acad. Sci.*, Vol. III, p. 398.

(All these occurrences are in one band of rock, and I have rarely failed to find cubical crystals at any locality and have never seen rhombic or fibrous forms. Professor Julien's careful studies make his determinations conclusive as to the presence of marcasite with the other sulphides.)

MARGARITE.

1865. Margarite. Chester.

"I found that the minerals margarite and chloritoid in talcose hornblende and mica-slate rocks indicated the occurrence of emery."

C. T. Jackson: *Am. Jour. Sci.*, Vol. XXXIX, p. 87.

1865. Margarite. Chester.

C. U. Shepard: *Am. Jour. Sci.*, 2d series, Vol. XL, p. 112.

1865. Margarite. Chester.

Scarcely less characteristic of emery than diaspore, harder and more basic than mica, nonalkaline, frequently with a richness of crystallization and color nowhere else known. Always in near proximity to the purest masses of emery, sometimes traversing it in veins, at others coating more or less perfectly large and small rounded masses of it with layers an inch or more in thickness. Laminae transverse; sometimes open spaces in middle of margarite seam show terminated crystals, but rarely with crystals of corundophyllite; emery grains everywhere; pinkish, rarely disseminated in emery with epidote; gray and resembles mica.

C. U. Shepard: Report of Chester emery mine, p. 10.

1866. **Margarite.** Chester.*Analysis.*

SiO ₂	32.21
Al ₂ O ₃	48.87
CaO	10.02
FeO	2.50
MnO	.20
MgO	.32
Na ₂ O (K ₂ O)	1.91
LO	.32
H ₂ O	4.61
TiO ₂	Trace.
	100.96

J. L. Smith: Am. Jour. Sci., 2d series, Vol. XLII, p. 90.

1866. **Margarite.** Chester.

Analysis by J. C. Jackson and C. T. Jackson.

Ibid., p. 107.

1885. **Margarite.**

The largest crystals that have come to my notice (100 mm. long), as well as the thickest veins of the mineral (65 mm.), are in the Clark cabinet in Smith College.

The mineral has widely divergent optical axes, and in the large crystals, which show plumose structure on cleavage planes, the successive laminae of the crystal are placed with their axes making a considerable angle with the axis of the composite crystal, so that in a plate of sufficient thickness exactly the same effect is produced as by building up plates of muscovite with the axes in each plate diverging more and more from the first.

1891. **Margarite.** Pelham asbestos mine.

In connection with the seam of deep blue corundum crystals, bordering the top of the olivine bed, one fine specimen of margarite has been found. Pale pink plates one-half inch across in fine dark bronze biotite. A second piece shows a fine drusy surface of satiny luster and pale-green color, formed by the terminations of many minute implanted crystals, presenting a common face to the surface. Form 0 P (001), ∞ P ∞ (010), ∞ P (100). The specimens were presented to the cabinet of Amherst College by Mr. B. F. Merrill.

MARMOLITE.

See Bastite.

MELANITE.

See Garnet, 1818.

MELANTERITE.

1818. **Sulphate of iron.** Conway.

Small quantity on mica-slate.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 115.

1823. **Sulphate of iron.** Hawley.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 233.

1892. Melanterite.

Efflorescence of iron sulphate is not uncommon in the Hawley schists, where pyrite is so abundant, and in the rusty Brimfield schists along the eastern border of the area. The local names "copperas rock" and "dye stone" indicate this.

In the band of rocks running under the western edge of Amherst village the sulphate is so abundant that the well waters sometimes blacken tea.

MELININE.**1876. Melinine** (yellow ocher). (Shepard.) Turners Falls.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 3.

See Limonite, 1823. Unused synonym.

MENACCANITE.**1824. Oxyd of titanium.** Chester.

"Likewise, I have seen the oxyd of titanium in plates in mica-schist."

E. Emmons: Lec. Min.; Am. Jour. Sci., 1st series, Vol. VI, p. 255.

1835. Iserine.

Some of the iron sand from the banks of the Connecticut River, 40 rods below Turners Falls, Montague side, not magnetic, and resembles iserine.

E. Hitchcock: Geol. Mass., p. 231.

1842. Washingtonite. (Shepard.) Goshen.

With spodumene, in thin folia.

C. U. Shepard: Am. Jour. Sci., Vol. XLIII, p. 366.

1844. Washingtonite. (Shepard.) Goshen.

F. Alger: Min., p. 381.

1846. Ilmenite, Washingtonite.

Analysis by J. L. Kendall:

TiO ₂	25.28
Fe ₂ O ₃	51.84
FeO	22.86
	99.98

Is identical in chemical composition and crystalline form with ilmenite.

F. Alger: Location of rare minerals and mines of supposed distinct species; Bost. Jour. Nat. Hist., Vol. V, p. 388; also Am. Jour. Sci., 2d series, Vol. I, p. 122.

1865. Ilmenite. Chester.

Thin, curved laminae with margarite.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, p. 112.

1865. Washingtonite. Chester.

Emery vein; rare, black, foliated, much-curved laminae between the double seams of margarite.

C. U. Shepard: Report of Chester emery mine, p. 11

1865. Washingtonite. Chester.

In the principal veins (layer veins) of white quartz that the large crystals of Washingtonite were found in, at one spot within a mile from the northern end of the emery vein.

C. U. Shepard: Discovery of emery mine, Chester; note, p. 5.

(There were in the Shepard collection, destroyed by fire, great tabular crystals 6 to 8 inches across and 1 inch thick of model-like perfection from the locality in Chester mentioned above. They were tabular by the predominance of 0. I can not find that they were ever described by Professor Shepard.)

1866. **Menaccanite.** Chester.

Flattened crystals in margarite.

J. L. Smith: Am. Jour. Sci., 2d series, Vol. XLII, p. 92.

1876. **Menaccanite.** Pelham, Ware.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 7.

1876. **Washingtonin.** Chester.

Ibid.

1880. **Menaccanite.** Blandford. Bartholomew's soapstone quarry.

In large plates in quartz in roadside opposite the quarry.

1881. **Menaccanite.** Ware.

In dull-black, flat crystals up to 1 inch; perfect and abundant in coarse granite near the railroad cut at Gilbertville.

1881. **Menaccanite.** Chester emery mine.

Massive in veinlets in emery; in beautiful, broad, finely striated scales bordering 1-inch vein of margarite and cutting corundophyllite.

1882. **Menaccanite.** Northfield. Calvin Swan's place.

Broad, thin plates in transparent quartz.

In W. E. Webster's collection in Northfield.

1891. **Menaccanite.** Hawley.

In quartz veins adjacent to the magnetite-hematite veins in very fine, large, curved plates in white quartz south of Forge Hill.

MICROCLINE.

1818. **Feldspar.** Deerfield, in pudding-stone.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. I, p. 113.

1823. **Adularia.** West Springfield. Southampton lead mine (Waterhouse).

In perfect crystals in coarse granite.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 221.

1824. **Green feldspar.** Chesterfield.

"While on a visit to the locality of sappare in that place, I found near the spot where the sappare is obtained fine specimens of green feldspar in granite and associated therewith the siliceous oxide of manganese (rhodonite). It contains small octahedral crystals of magnetite."

C. U. Shepard: Loc. Min.; *ibid.*, Vol. VII, p. 251.

1825. **Green feldspar.** Chesterfield. Green.

Chester; pale-green color, not uniform in structure, foliated, less luster than lighter varieties. Glossy quadrangular prisms in quartz, abundant (Emmons).

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 43.

1825. **Green feldspar.** Chesterfield.

In crystals, in masses; fine; near cyanite location in granite.

Robinson's Cat., p. 43.

1835. **Feldspar.** Pelham.

Feldspar crystals with actinolite, augite, and sphene.

E. Hitchcock: Geol. Mass., p. 398.

1841. **Feldspar.** Belchertown.

In gneiss in Three Rivers. Small but well-defined crystals, primary form with truncation of solid angles, in drusy cavities in tortuous gneiss; also on railroad in Middlefield; Leverett, blue; Goshen, green.

E. Hitchcock: Geol. Mass., pp. 637, 639, 703.

1852. **Feldspar.** (**Adularia.**) Palmer, Middlefield.

Most interesting crystallizations.

C. U. Shepard: Min., 3d ed., p. 189.

1876. **Blue microcline.** Hadley.

From coarse granite dike in Mount Warner, Hadley.

Analyzed by J. Keep, of the class of 1874, Amherst College:

	No. 1.	No. 2.
K ₂ O	11.62	11.03
Na ₂ O	3.72	3.90
	15.34	14.93

1876. **Microcline.** (Des Cloizeaux.) Everett (correctly Leverett).

Des Cloizeaux: Un microcline blanc d'Everett, Mass., U. S. A.; Compt. Rendu, Vol. LXXXII, p. 889.

Professor Shepard informed me that the microcline of Leverett furnished by himself was one of those originally investigated by Des Cloizeaux. As there is no rock in Everett, Mass., which could furnish the mineral, the citation above originated doubtless from reading Leverett "L'Everett" on Professor Shepard's labels.

1876. **Microcline.** L'Everett.

Analysis by Pisani.

SiO ₂	64.97
Al ₂ O ₃	21.47
MgO.....	.32
K ₂ O	12.20
Na ₂ O	1.78
Ign.....	.81
	101.55
Sp. gr.....	2.47

Des Cloizeaux: Ann. Ch. Phi., Vol. IX, p. 433.

1880. **Microcline.** Amherst.

West of middle of long dike east of North Amherst.

Pegmatitic nodules in feldspathic mica-schist, same as original locality in Leverett, changing into a silvery-white muscovite along planes of the following cleavages, which are placed in order of clearness of development: '∞ P', 0 P, ∞ P ∞, ∞ P ∞. They are in the progress of and as a result of the decomposition of the feldspar and its change to muscovite. Under the microscope the nodules show the structure of microcline. They gave 15 per cent alkali, mostly K₂O.

1880. **Quartz and feldspar.** Hampden County.

Number of mines.....	2
Capital.....	\$254, 000
Hands.....	23
Wages.....	\$12, 300
Value of material (per ton).....	\$1, 600
Product, tons.....	3, 400
Product, value.....	\$44, 000

U. S. Census, 1880, Vol. XV, p. 844.

(This refers to the mines of the Pontoosuc flint mills in Blandford, and probably to the quarry near Knightville in Huntington.)

1885. **Microcline.** Pelham, Monson, Huntington, Russell, Granville, Blandford.

Pelham; occurs in distinct large crystals 7 cm. long; $\infty P \infty$, $' \infty P'$, $0 P$, $P \infty$, P ; white with trace of pink in coarse granitic segregations in Pelham gneiss, Buffom's quarry, T. J. Aldridge, owner.

Monson; in large, nearly transparent, cleavable masses in coarser portions of the gneiss at the south end of Flynt's quarry.

In Huntington the large masses with the spodumene on Norwich Hill often have the green color of Amazon stone.

Russell; left bank of the river, opposite Lower Salmon Falls.

Granville; near Munns Brook.

Blandford; north line at feldspar quarry; fine large cleavable masses and many well-formed crystals a foot on a side.

1889. **Microclin.** Huntington.

"A considerable force of men is at work on the farm of George D. Lyman, near Knightville in Huntington, blasting for feldspar. If found in paying quantities, it is proposed to build a mill near by for crushing it."

Springfield Republican, April 18, 1889.

(Fine white microcline occurs in large masses forming a giant pegmatite.)

MICROLITE.

1835. **Microlite.** Chesterfield.

Full mineralogical description, O , $O \infty O$, $2 O 2$. In albite; conjectures that the principal ingredient is oxide of cerium.

C. U. Shepard: Microlite, a new mineral species; Am. Jour. Sci., 1st series, Vol. XXVII, p. 361.

1835. **Microlite.** Chesterfield.

Octahedral tungstic baryte.

Full description and figures, O , ∞O , O , $2 O 2$. Its chief ingredient is probably the oxide of cerium. Largest crystals, 0.4 gr.

C. U. Shepard: Min., Part II, Vol. II, p. 45.

1837. **Microlite.***Analysis.*

CbO	75.70
CaO	14.84
WO ₃ }	
YO }	7.42
UO }	
HO	2.04
	100.00

C. U. Shepard: Chemical examination of microlite; Am. Jour. Sci., 1st series, Vol. XXXII, p. 338.

1841. Microlite. Chesterfield.

A new mineral, chiefly an oxide of cerium.

E. Hitchcock: Geol. Mass., p. 704.

1842. Pyrochlore. Chesterfield.

Transparent straw-yellow to brick-red and black, the transparent and smaller crystals being beautifully modified.

Analysis by A. A. Hayes:

TiO ₂	80.0
SnO }	11.8
FeO }	
CeO }	
UO }	
CaO	8.2
	100.00

J. E. Teschemacher and A. A. Hayes: On the identity of pyrochlore with the microlite of Professor Shepard; Am. Jour. Sci., 1st series, Vol. XLIII, p. 33.

1842. Microlite. Chesterfield.

Maintains the species microlite and gives chemical proof that it is a columbate of lime and yttria.

C. U. Shepard: Want of identity between microlite and pyrochlore; Am. Jour. Sci., 1st series, Vol. XLIII, p. 116.

1844. Pyrochlore.

"The close examination of above 200 crystals of the mineral named microlite by Professor Shepard * * * indicated to me in 1841 the complete identity of the mineral with pyrochlore. This identity, strenuously resisted by Professor Shepard, though on grounds which show a very superficial acquaintance with the whole subject, has been completely proved by subsequent analyses, particularly by that of A. A. Hayes (Am. Jour. Sci., 1st series, Vol. XXXII, p. 341), and its station as a columbate of lime, according to one of Shepard's analyses, confirmed. My largest crystal is three-eighths of an inch at base of pyramid."

J. E. Teschemacher: Bost. Jour. Nat. Hist., Vol. IV, p. 501; Philos. Mag. of London, Edinburgh, and Dublin, 1844.

1844. Microlite ?. Chesterfield.

Mr. Teschemacher has called my attention to some minute transparent yellow and highly brilliant crystals which, with columbite and microlite, are found in the Chesterfield granite. They have the characters of a columbite, but differ from true microlite. Mr. Teschemacher has a crystal of microlite much modified by an uranium mineral crystallized with it. Generally the yellow stains on the albite are the most marked indications of the existence of microlite crystals.

Note: A. A. Hayes; Am. Jour. Sci., 1st series, Vol. XLVI, p. 159.

1844. Microlite. Chesterfield.

Acknowledges error in calling the mineral a titanate in previous analysis and communicates new analysis of microlite and of the foreign pyrochlore, from which he concludes that they are the same mineral.

A. A. Hayes: Reexamination of microlite and pyrochlore; *ibid.*, p. 158.

1845. Microlite. Chesterfield.

Maintains its identity with pyrochlore and explains the specific gravity by the greater quantity of columbic acid, 80 per cent, as against 53 per cent in pyrochlore.

J. E. Teschemacher: Am. Jour. Sci., 1st series, Vol. XLVIII, p. 395.

1845. **Microlite.** Chesterfield.

"The dimensions of the controversy to which this little mineral has already given rise seem half entitled to place it under gigantolite." In answer to Hayes's chemical reexamination of the mineral and interpretation of his (Shepard's) results, Shepard quotes Berzelius's Report of Progress, where he concludes from the researches published that the mineral is only a yellow yttrio-tantalite. Shepard concludes that "the whole mineralogical question then—if there still be any—comes back to the point where I had left it, viz, to the difference in regard to gravities. Pyrochlore has a gravity of 4.20 to 4.32; microlite, 5.48 to 5.646. As soon as Mr. Teschemacher with his 200 crystals (which is a twenty-fold greater number than I have had the good fortune to see) shall by simple observation with the balance cause this discrepancy to disappear, etc., then the species will disappear."

C. U. Shepard: *Ibid.*, p. 177.

1852. **Microlite.** Chesterfield.

Description.

C. U. Shepard: *Min.*, 3d ed., p. 248.

1868. **Microlite.** Chesterfield.

From blowpipe investigation suggested by Brush to be probably a pyrochlore in which tantalic acid replaces the columbic, this corresponding with the high specific gravity and larger percentage of the metallic acid. (?) $[\text{CaO}, \text{MnO}]\text{TaO}_5$.

J. D. Dana: *Min.*, p. 514.

1892. **Microlite.** Chesterfield.

E. S. Dana: *Min.*, p. 728.

MOLYBDENITE.

1818. **Molybdena.** Shutesbury, on land of William Eaton.

Crystals flat six-sided prisms 1 inch or more in length; in ledge 6 to 7 feet above surface of earth, 10 to 12 feet above water.

E. Silliman: *Not. of Min. Loc.*; *Am. Jour. Sci.*, 1st series, Vol. I, p. 238.

1819. **Sulphuret of molybdena.** Brimfield.

In granite traversing gneiss; very common.

A. Eaton: *Min. Loc.*; *ibid.*, Vol. II, p. 238.

1820. **Sulphuret of molybdena.** West Brimfield.

Granite, discovered by Dr. A. Lincoln.

A. Eaton: *Index*, p. 94.

1822. **Molybdena.** Middlefield.

In actynote and steatite.

C. Dewey: *Min. Loc.*; *Am. Jour. Sci.*, 1st series, Vol. V, p. 268.

1823. **Sulphuret of molybdena.** Brimfield (Eaton).

E. Hitchcock: *Geol. Conn. River*; *ibid.*, Vol. VI, p. 235.

1824. **Molybdenite.** Chesterfield.

Dr. J. Porter: *Loc. Min.*; *Am. Jour. Sci.*, 1st series, Vol. VII, p. 58.

1824. **Sulphuret of molybdena.** Chesterfield.

Six-sided prisms in quartz.

C. Dewey: *Geol. Berkshire County*; *ibid.*, Vol. VIII, p. 58.

1825. **Molybdena.** Goshen.

In granite.

J. Porter: *Min. Loc.*; *ibid.*, Vol. IX, p. 55.

1825. **Molybdenite.** Chesterfield, Goshen, Middlefield

In actinolite and steatite.

Robinson's Cat., pp. 43, 51, 59.

1828. **Molybdena.** Shutesbury.

"Went in search of location mentioned in American Journal of Science (1st series, Vol. I), on land of William Eaton; could not find any such person nor ascertain that he ever owned land in that place, though he was recollected. Ascertained at length that the spot was on land of Mr. Pratt, in the extreme northern part of the town, close by a common chalybeate spring. In granite in mica-slate. Few specimens to be obtained without blasting."

E. Hitchcock: Min. Ex.; Am. Jour. Sci., 1st series, Vol. XIV, p. 217.

1835. **Molybdenite.** Shutesbury.

Figured.

C. U. Shepard: Min., Part II, Vol. II, p. 52.

1835. **Sulphuret of molybdenum.**

Said to have been found in Middlefield steatite.

E. Hitchcock: Geol. Mass., p. 363.

1838. **Sulphuret of molybdenum.** Brimfield.

With iolite, $1\frac{1}{2}$ miles northeast of village, land of Samuel Patrick. Abundant in dots.

J. W. Foster: Am. Jour. Sci., 1st series, Vol. XXXIII, p. 400.

1841. **Sulphuret of molybdenum.**

Shutesbury; Lock's Pond: In hexagonal plates nearly an inch in diameter in gneiss.

In boulder in gneiss in Pelham, Middlefield.

E. Hitchcock: Geol. Mass., pp. 613, 637.

1844. **Molybdenite.** (*Elasmites hexagonus*.) Shutesbury.

J. D. Dana: Sys. Min., p. 500.

(I have not been able to verify any of the above localities except that at Shutesbury. The Brimfield iolite occurs in small granite veins in the highly graphitic Brimfield schist. I have not been able to find molybdenite at the locality, and probably graphite was mistaken for it.)

1894. **Molybdenite.** Chester.

In vein in chloritic hornblende-schist with pale-green epidote from the upper portion of the main shaft at the emery mine.

In distinct tabular crystals, apparently $P, 0 P, \infty P$. P striated; $0 P$ depressed to a regular six-faced, hopper-shaped cavity, suggesting the idea that it may be a twinned crystal in the rhombic system.

MONTMORILLONITE.

1825. **Carbonate of manganese.** Goshen.

The spodumene is almost uniformly invested with a very thin coating of carbonate of manganese; in the interior pulverulent and delicate rose-red; at the surface brownish-black.

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 607.

1876. **Quincite.** Goshen.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College.

This refers, as specimens in the Shepard collection with the author's label showed, to the pink coloring films upon the altered spodumene. I know no evidence except color which could cause one to assign the substance to the limestone mineral quincite, and I prefer to follow Dana and Brush in assigning it to montmorillonite.

1879. **Montmorillonite.** Norwich (now Huntington).

"By the deposit of a pink substance at Norwich acting as a characteristic coloring film upon spodumene."

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 326.

1886. **Montmorillonite.** Southampton.

In thin, pink, botryoidal crusts at the Loudville lead mine on decomposed granite.

1891. **Montmorillonite.** Belchertown.

Similar crusts upon the fissures in the mixture of granite and hornblende schist at Kellys Crossing.

MUSCOVITE.

1818. **Mica.**

Abundant east of the Connecticut River. In crystals in Amherst.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 113.

1820. **Mica.** Chester or Westfield.

Hexagonal crystals in granite.

Chester Dewey: Loc. Min.; *ibid.*, Vol. II, p. 237.

1823. **Mica.**

Cummington and Plainfield, green; Williamsburg, white and yellowish, abundant.

J. Porter: Loc. Min.; *ibid.*, Vol. VI, p. 248.

1823. **Mica.**

Leverett; laminated, lamellar. Goshen, yellowish-green and violet, and sometimes in rhombic tables (Gibbs).

Most of the mica in the granite veins in Conway, Ashfield, Williamsburg, Chesterfield, etc., is straw-yellow, sometimes rose-red, and in these veins it exists in excess. It occurs in these and other towns, also in granite and of a smoky or nearly black color.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 220.

1824. **Prismatic and tabular mica.** Norwich (Huntington).

Abundant and very beautiful at White Rocks, one-half mile west of and visible from Pitchers Ridge. In coarse granite.

E. Emmons: *Ibid.*, Vol. VII, p. 254.

1824. **Prismatic mica.** Chesterfield and Goshen.

Abundant.

J. Porter: Min. Loc.; *ibid.*, Vol. VII, p. 253.

1824. **Mica, prismatic.** Chester.

Fibrous, very fine, passing into prisms; also Worthington; Williamsburg, plumose.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 41.

1825. **Mica.** Goshen.

Green, rose, and silver colored; also beautiful white talc, which I believe has not been credited to this locality (= cymatolite).

E. Hitchcock: Min. Loc.; *ibid.*, Vol. IX, p. 21.

1827. **Plumose mica.** Williamsburg.

Six inches long.

A. Nash: Lead mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 260.

1835. **Plumose mica.** Williamsburg; several places west and northwest of the village.

E. Hitchcock: Geol. Mass., p. 504.

1841. **Mica.**

Chesterfield and Goshen; rose-red, delicate yellow, transparent, and silver. Northwest of Norwich, nearly 2 feet in diameter. Prismatic mica in Goshen, Chesterfield, Norwich, Leverett; best at Russell. Plumose mica in Williamsburg west and northwest of village.

E. Hitchcock: Final Report, p. 701.

1846. **Damourite.** Chesterfield.

Yellow, amorphous; found in very small quantity; gives off water, becomes milk-white. Before the blowpipe melts with great difficulty into white enamel, colorless bead, blue with cobalt. Silica, alumina, with little potash. In recesses in the albite and seems to have undergone strong pressure.

Teschemacher: Proc. Bost. Soc. Nat. Hist., Vol. II, p. 107.

1857. **Mica.** Chesterfield.

The rose-colored mica contains:

K ₂ O.....	9.08
Na ₂ O.....	.99
Li ₂ O.....	.64
H ₂ F1.....	1.89

Angle of optic axes, 74.76.

J. W. Mallet: Am. Jour. Sci., 2d series, Vol. XXIII, p. 180.

1879. **Muscovite pseudomorphs after spodumene.** Chesterfield Hollow. Goshen, Barras farm.

"Many pseudomorphs were found in the Chesterfield vein which consist in large part or entirely of a greenish-yellow muscovite of a peculiar greasy luster. In fact all stages of admixture with cymatolite were observed from the almost pure pseudomorphs of the latter mineral, in which muscovite occurred only in minute or even in microscopical scales, lying mostly parallel to the axis of the crystals—to others in which the mica was so abundant as to have imparted a yellow or greenish color to the mixture and at last to micaceous pseudomorphs, perfectly free from cymatolite. All these varieties of intermixture appear to be rather the results of intercrystallization than of alteration of either one of the pseudomorphous minerals into the other. In another form the pseudomorph in albitic granite graduates into pure muscovite in irregular granular arrangement, producing prisms of great size. At the Barras farm 'aglaite' and muscovite are intercrystallized in similar ways. The change of spodumene into muscovite seems to consist in an exchange of alkalies and removal of 2SiO₂ from the molecule of spodumene."

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 347.

1879. **Killinite.** Chesterfield, Huntington.

"Found frequently, but in limited quantities, at Chesterfield Hollow, and quite rarely in the Huntington vein."

It occupies the entire core of some of the smaller cymatolite pseudomorphs after spodumene, but ordinarily appears as a layer between it and the outer crust of cymatolite (q. v.). Texture foliated; H. = 3.5; luster dull and greasy; color greenish-gray to olive-green. Under the microscope the straight parallel fibers of killinite are continued in the curved needles

1879. **Killinite**—Continued.

and blades of the cymatolite. From the analysis below is deduced the formula for killinite: $H_2K_2Al_2Si_5O_{18} + 2 \text{ aq.}$ which is derived from the doubled molecules of spodumene ($Li_4Al_2Si_8O_{24}$), by the replacement of Li_4 by (H_2K_2) , the removal of $(3SiO_2)$, and the addition of $(2H_2O)$, and this change is assumed to have been caused by "meteoric alteration," by surface waters charged with organic acids and their ammoniacal salts combined with potassa derived from the orthoclase, and to be subsequent to the formation of cymatolite.

SiO ₂	46.80
Al ₂ O ₃	32.50
FeO	2.33
MnO	.04
CoO	.04
MgO	.48
CaO	.77
Li ₂ O	.32
Na ₂ O	.78
K ₂ O	7.24
H ₂ O	7.66
Nitrogenous organic matter	1.14
	100.12

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 354.

1880. **Killinite**.

Proved to be probably a hydrous muscovite, or sericite.

G. J. Brush and E. S. Dana: The spodumene of Branchville; Am. Jour. Sci., 3d series, Vol. XX, p. 274.

(In view of the results reached by Brush and Dana in the paper above, we may call attention to the close similarity—chemically—of killinite and muscovite and the greater simplicity of the explanation suggested by Professor Julien (p. 349) for the change of spodumene into muscovite—the separation of $(2SiO_2)$ from a molecule of spodumene—as compared with the explanation quoted above for the change of spodumene to killinite.

It is more interesting to see that the two explanations are in essence almost identical, and since the last-quoted explanation is based on an elaborate discussion of a single analysis of a substance which is probably a mixture, I think we are justified in accepting the simpler and extending it somewhat more than the author does to cover the change of spodumene to "killinite" as well as to the coarsely crystalline muscovite.

Killinite is thus the cryptocrystalline representative of the mica pseudomorph as cymatolite is of the granitic.)

1880. **Mica**. Hampden County.

Number of mines	1
Capital	\$5,000
Workmen	25
Wages	\$750
Explosives	\$600
Product, pounds	1,000
Product, value	\$1,250

Tenth Census, 1880, Vol. XV, pp. 843, 851, 852.

On page 851 the product is given as 1,000 tons. This refers to the mine of the Pontoosuc flint mills, situated on the mountain south of their mills and in the town of Blandford.

1881. **Muscovite.** Williamsburg.

"Plumose mica abounds on what is known here as Gear Hill, about 1 mile northwest, near the hamlet called Searsville. I have found it plentiful there for some sixty years, and have supposed it the best locality known; found only within the circuit of a few hundred acres."

Morris Dwight (letter to the author).

1882. **Muscovite.** Goshen.

I have found pseudomorphs of muscovite after spodumene on the north shore of Lily Pond, in the northwest of Goshen.

1883. **Muscovite after microcline.** Amherst.

West of middle of long dike east of North Amherst.

Muscovite, white, developed on the cleavages 0, 'P', ∞ P ∞ , ∞ P ∞ , of nodules of microcline until it nearly takes its place.

1886. **Muscovite.** Monson. Flynt's quarry, east side.

In imperfectly bounded crystals up to 8 inches square; cleavage planes occupied by a twinned network of flattened crystals of magnetite, as in the muscovite of Pennsbury, Pa. The pattern is here finer and more delicate, and there is always a free border one-half inch wide in the muscovite which is free from the magnetite. The crystals occur in the upper edge of a small pegmatite dike which penetrates the gneiss from below and comes to its upper limit in the middle height of the quarry.

1886. **Muscovite.**

The "lithionglimmer" of Chesterfield and other North American localities contains stannic acid.

F. Sandberger: Untersuchungen über Erzgänge, p. 191.

1891. **Muscovite.** Russell.

In columnar crystals.

C. Hinze: Min., p. 629.

NATROLITE.

1818. **Zeolite.** Deerfield.

Rare, radiated.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. **Zeolite.**

Radiated fibrous masses sometimes as large as a musket ball, or, more rarely, an inch in diameter.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 224.

1824. **Fibrous zeolite.** Chester.

Associated with prehnite in fibrous masses (Emmons).

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 45.

1841. **Thomsonite.**

In the amygdaloid on the east side of the greenstone range in Deerfield and Greenfield; a few rather poorly characterized radiated specimens exceedingly resembling the thomsonite of Scotland.

E. Hitchcock: Geol. Mass., p. 662.

1882. **Natrolite.** Deerfield.

This mineral occurs in loose tufts of very minute needles 0.01 to 0.004 mm. in diameter, coating prehnite, especially in those specimens where epidote was abundant. It was not found associated with datolite or any of the succeeding minerals. The needles were colorless when fresh, but large pieces of rock were thickly covered with brown tufts of apparently the same mineral, which gave a black bead with the blowpipe and seemed to be nearly transformed into limonite.

1882. Natrolite—Continued.

The natrolite is succeeded in the prehnite-epidote veins only by calcite, acute scalenohedra inclosing whole tufts of the former mineral, and by fluorite, which is speared upon the delicate needles of the natrolite in minute, transparent, colorless octahedra, pierced through a hexahedral axis. From one to four of these are strung upon a single needle, often at the very tip, and in one field of the microscope ($\times 40$) I counted seventeen; and the whole, having as a background the deep-green polished faces of the epidote crystals upon which the group rested, made an object of great beauty. It undergoes also an extremely peculiar alteration into saponite, and further appears in hollow pseudomorphs apparently of saponite—acute prisms resembling epistilbite.

B. K. Emerson: Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXVI, p. 355.

1882. Natrolite. South Hadley.

Following up Dry Brook in the northwest of South Hadley to the point where it runs on the line of contact of sandstone on trap, the latter is coarsely amygdaloidal and the cavities are filled with radiated natrolite which make exquisite preparations for the microscope.

1891. Natrolite. Buckland, near Shelburne Falls.

In quarry on railroad in white gneiss. Tufts of white needles. Very rare. Associated with axinite.

NEPHRITE (?).

1824. Jade (subspecies of nephrite). On Westfield River.

Very tenacious; scratches quartz; of pale-green oily aspect; fragments splintery and fracture dull; rare (Emmons).

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 43.

(This can not be identified. It is possibly a green hornstone or silicified serpentine from the Middlefield bed.)

OLIGOCLASE.

1865. Amphodelite. Chester.

The diasporite is associated with rose-colored amphodelite.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, p. 112.

1865. Indianite. Chester.

"A vein of indianite many inches thick is found near the tunnel in South Mountain running for many rods through the chloritic rock on the east side of the emery vein (exterior to its gneissoid wall). This chloritic seam is called by the workmen 'the fringe rock.' Small particles of the corundum are diffused through the indianite."

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XL, p. 123.

1866. Andesine. Chester.

The rock originally mistaken by me for granular quartz and called indianite by Shepard proves on analysis to be andesine, although it is harder than stated in the books, scratching quartz easily. It is associated with crystals of black tourmaline; compact, fine granular. Sp. gr. 2.586; H. 7.5; color slightly greenish-white.

1866. **Andesine**—Continued.*Analysis.*

	No. 1.	No. 2.
SiO ₂	62.00	60.00
Al ₂ O ₃	24.40	25.00
CaO	3.50	.....
MgO	.70	.....
Na ₂ O	8.07	.....
H ₂ O	1.00	.....
	99.67	.....

C. T. Jackson: Analysis of seven minerals from the emery mine of Chester; Am. Jour. Sci., 2d series, Vol. XLII, p. 107.

1868. **Indianite.** Chester.

Exterior to the vein on its eastern side, a few feet within the talcose slate on South Mountain, near Deerfield River, is a layer 6 inches to 2 feet thick called locally "the fringe rock." Through the middle runs a vein of indianite 2 to 10 inches; massive, fine granular, yellowish; contains corundum.

C. U. Shepard: Report of the Chester emery mine.

The mineral shows all the optical properties of oligoclase.

1887. **Oligoclase.** Palmer; boulder at house of R. Printible.

In boulders of coarse hornblende biotite gneiss; large masses 1 to 2 dm. across of a curious very fresh feldspar; color shading from white to pitch black, in large patches. Marked conchoidal fracture and glassy luster, and tabular parting rudely parallel to a prism face. Rarely a brilliant basal cleavage without pearly luster and with fine twin striation; color due to parallel microscopic needles exactly like those in labradorite; sp. gr. 2.63; extinction, 2° 48' on 0 P. Traces of play of colors on ∞ P ∞ .

Analysis by G. H. Corey, class of 1888, Amherst College:

SiO ₂	64.74
Al ₂ O ₃	22.48
CaO	4.54
Na ₂ O	7.84
K ₂ O	.26
	99.86

This equals 6 Ab: 1 An.

OPAL.

1821. **Stalactitical quartz.** Cummington.

J. Porter: Am. Jour. Sci., 1st series, Vol. VI, p. 247.

1821. **Opal, Hyalite.** Middlefield, Worthington.

Dirty-brown.

Robinson's Cat., pp. 59-78.

1823. **Opal.** Middlefield (Emmons).

J. Porter: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VI, p. 248.

1824. **Siliceous sinter, hyalite.**

In serpentine in Middlefield (Emmons); sometimes nearly stalactitical (Porter); dirty-brown, coarse, ferruginous in Middlefield; reddish-brown with whitish spots (Emmons).

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 39.

1841. **Hydrate of silica.** Pelham.

E. Hitchcock: Geol. Mass., p. 99.

1876. **Opalite.** Variety of *hyalin*. Monson and Greenfield.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 5.

1881. **Hyalite.** Monson, Pelham.

Monson. Delicate chrysocolla green to colorless layers on gneiss and hornblendic gneiss at Flynt's quarry.

Pelham. In colorless layers, botryoidal, on gneiss in quarry above bridge over Amethyst Brook.

1882. **Hyalite.** Greenfield.

A colorless hyalite of fine botryoidal structure covers, with a thick layer, broad surfaces in the dark-gray diabase from the cuttings for the new road from Greenfield to Turners Falls, where also pearly white botryoidal layers are very abundant and seem in many cases to be of very recent origin, and to have coated minute rootlets, which had penetrated the fissures and lay across the botryoidal surface.

B. K. Emerson: Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 355.

1883. **Opal.**

Large boulders in Amherst, probably from Conway, highly ferruginous and full of small balls of limonite and show drusy chalcedonic surfaces.

Heated thirty hours with 20 per cent solution of KHO, only 46.61 per cent remained insoluble; loss by ignition, 2.94. The citations of the Conway locality are given under Quartz.

1883. **Hyalite after barite.** Leverett, eastern lead mine.

E. J. Whitaker, class of 1883, Amherst College.

ORTHOCLASE.

1820. **Adularia.** Brimfield.

In gneiss and granite. Nearly equal to that of the Alps. Near residence of the late Gen. William Eaton.

Am. Jour. Sci., Vol. V, p. 41; also Amos Eaton, Index, p. 94.

1832. **Adularia.** Brimfield, near center of town.

Greenish; used as a gem.

E. Hitchcock: Geol. Mass.; Am. Jour. Sci., 1st series, Vol. XXII, p. 50.

1838. **Adularia.** Brimfield, one-half mile northeast of village, Warren road, near house of Samuel Patrick.

With iolite; chatoyant; striated.

J. W. Foster: Am. Jour. Sci., 1st series, Vol. XXXIII, p. 399.

1883. **Adularia.** West Northfield.

In minute simple crystals ∞ P, 0 P, 2 ∞ , in drusy surfaces and in larger crystals up to 8 mm., deeply corroded on prism face parallel to the vertical axis, associated with radiated cleavelandite. On Devonian quartzose mica-schist at end of clearing, southwest of South Vernon.

1887. **Orthoclase** var. moonstone. Brimfield, Monson, east part; Wales, Holland.

The fresh transparent feldspar cited above as adularia agrees exactly with the moonstone of Ceylon. It occurs in small lenticular inclosures in the Brimfield schist. Quite large cleavage pieces can be obtained which are wholly free from fissures, and with fine opaline luster. The extinction on 0 P is 0.

1895. **Orthoclase.** Var. **Chesterlite.** Warwick.

Small flesh-colored crystals, $\frac{3}{4}$ mm. across, in druses in the epidote-garnet rock. South of the village. ∞P , $0 P$, $P \infty$.

OTTRELITE.

See Chloritoid (1865) and Biotite (1852).

PELHAMINE.

See Chrysolite (1876).

PELHAMITE.

See Chrysolite (1876) and Jefferisite (1875).

Pelhamite of Cooke 1875 (= jefferisite) antedates pelhamine of Shepard 1876, which is the least altered form of an eruptive rock. Both words should be retired to the list of synonyms.

PETALITE (?) or SCAPOLITE.

1841. **Petalite (?) or scapolite.** Westfield.

In serpentine in a vein nearly a foot wide.

E. Hitchcock: Geol. Mass., p. 618.

(Probably refers to the enstatite bed at Munn's Brook. See p. 77.)

PHENAKITE.

See Beryl, 1838.

PHLOGOPITE.

1885. **Phlogopite.** Middlefield.

In the pre-Cambrian limestone in the railroad cutting on Coles Brook, in small yellow and bronzy scales.

PHOSGENITE.

See Anglesite.

PHYLLITE.

See Biotite.

PIHLITE.

1868. **Pihlite.**

See Cymatolite (1868).

PIMELITE.

1825. **Pimelite.** Middlefield.

"In the neighborhood of the spot where the crystallized steatite is found Dr. Emmons and myself discovered very beautiful pimelite. It occurs in serpentine. It possesses a very deep apple-green color, is very pliable, and when first broken from a cavity is greasy to the touch."

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 609.

(This is not again cited by Professor Shepard.)

1826. **Pimelite.** (Nickel coloring clay.) Middlefield.

Small quantities in cavities in stalactitical quartz; color fine grass-green. The masses when first broken present a granular structure; when dry, become compact and full of cracks and fissures; in quartz connected with serpentine.

E. Emmons: Min. Not.; Am. Jour. Sci., 1st series, Vol. X, p. 11.

The two citations are interesting as showing that the localities of "stalactitical quartz," (that is, the yellow chalcedony of Chester) and the "crystallized steatite" (that is, the olivine pseudomorph in serpentine) are near together, probably in the brook bed crossing the serpentine near its base.

PINITE.

1825. **Pinite.** Chester.

Generally amorphous; in granite traversing mica-slate, one large crystal obtained measuring $2\frac{1}{2}$ inches in diameter; not abundant.

E. Emmons: Min. Loc.; Am. Jour. Sci., 1st series, Vol. X, p. 11.

1841. **Pinite.** Chester (Emmons's Mineralogy).

E. Hitchcock: Geol. Mass., p. 605.

PLATINUM?

1838. **Platinum?**

Dr. H. Holland thought he obtained a trace of platinum from Chester chromite.

E. Hitchcock: Econ. Geol., p. 125.

PREHNITE.

1818. **Prehnite.** Deerfield.

In greenstone, incrusting the columns in radiated masses, rarely crystallized; veins nearly perpendicular.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. **Prehnite.** Deerfield, Greenfield, etc.

In Deerfield radiated masses sometimes contain pyritous copper which occurs also on pseudomorphous quartz, and has evidently been formed since the decomposition of the crystals originally occupying the cavities; also on chalcedony.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 223.

1824. **Prehnite.** West Springfield.

In secondary greenstone, in radiated masses.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 45.

1825. **Prehnite.** West Springfield.

In greenstone; in green radiating fibers, decaying; poor.

Emerson Davis: Min. Not.; *ibid.*, Vol. IX, p. 252.

1825. **Prehnite.** Greenfield.

In greenstone (Hall).

Robinson's Cat., p. 52.

1835. **Prehnite.** Turners Falls, on Greenfield side.

Nearly white; more common on eastern side of greenstone ridges. Example: Mouth of Deerfield River and 4 to 5 miles south at Pine Nook in Deerfield; in West Springfield no very rich specimens.

E. Hitchcock: Geol. Mass., p. 434.

1841. **Prehnite.** Belchertown, in gneiss; Three Rivers.

E. Hitchcock: Final Report, p. 639.

(Should be Palmer.)

1841. **Prehnite.** Greenfield, West Springfield.

Common in amygdaloid; color nearly white; more common on eastern side of ridge than western. Examples: Notch of Deerfield River, on east side of same ridge, 4 to 5 miles south at Pine Nook; also West Springfield on west side of ridge; also 1 mile east of Deerfield church, and 1 mile east of Greenfield. Finest specimens at cutting of Western Railroad in West Springfield. The balls of radiated prehnite here occupy veins in the rock along with calcareous spar, which often invests the prehnite with minute crystals. (This last locality is the Tatham cut in the posterior trap. Specimens preserved in the State collection at Amherst.)

E. Hitchcock: Geol. Mass., p. 661.

1859. **Prehnite.** Three Rivers, Palmer.

"On gneiss."

E. Hitchcock; *ibid.*, p. liv.

(Nearly perfect discs with slightly bulging faces and milled edges like a thick coin. Specimen in the State collection at Amherst.)

1859. **Prehnite.** West Springfield.

"On greenstone."

E. Hitchcock: Cat. State Col., Agr. Rep. Mass., app., p. lvii.

1882. **Prehnite.** Pelham.

Ward's quarry on joint in Pelham gneiss. In minute, flat, blade-like crystals $0P, \infty P, \infty P \propto$, pale mountain green, often slightly covered with rust layer; in stout crystals 5 mm. to 6 mm. long with same faces or only $0P, \infty P$; ∞P is curved and 0 slightly rounded; same color. The latter form is in single crystals and not twinned as in the trap prehnite from Deerfield, as it polarizes simply. Paragenesis:

Gneiss,

Quartz,

Epidote,

Prehnite,

Scolecite,

Pyrite,

Kaolin,

Limonite.

Found by H. A. Smith and others of class of '83, Amherst College.

1882. **Prehnite.** Deerfield. At Cheapside, south of the river.

In fissures.

Prehnite occurs here most abundantly and always as the oldest mineral in the veins in which it appears. That the veins where it is absent have been filled at a later period and at a lower temperature is evident from the fact that in these the vein walls are quite as fresh as the body of the rock, while in the prehnite veins the walls are deeply decomposed, often to a depth of several centimeters into a rusty vesicular mass, which has been filled with massive prehnite, forming a rock nearly as compact as the trap itself. Similarly many detached fragments of the trap have been thoroughly decomposed and in the same way filled with massive prehnite. Under the microscope the mineral is here seen to be made up of fibers variously matted and interlaced and intermingled with the remains of the trap, and much of it exactly resembles chlorastrolite. In other specimens the oldest layer of the mineral is jet-black to deep oil green, polished and

1882. **Prehnite**—Continued.

often slickensided and gashed, the color being due to the thorough impregnation of the prehnite with diabantite. The motion of the rock walls has also at times broken up the prehnite into sheets, which are slipped over each other variously and recemented by prehnite. Wherever the mineral is hindered in its growth it shows a strong tendency to take on these fibrous forms, which seem to me to depend upon a greater energy of the crystallizing force in the direction of the long horizontal axis; upon which depends also the curvature of the faces so common in the species. Generally these fibers are quite large, peculiarly rigid, and in large numbers parallel to each other. In one slickensided piece the fibers of black prehnite, all straight and parallel and placed at a slight angle to the surface of the trap, seem as if combed into this position by the movement of the walls, and, being jet-black from inclosed diabantite, resemble in appearance seams of fibrous hornblende or chrysotile.

The fibers are, however, generally colorless, transparent, and of a high satiny luster on the face $0P$. They are apparently always elongated in the direction of the long horizontal axis and bounded by the planes $0P$, $\infty P\bar{\infty}$, $\infty P\infty$. At times the satiny luster is reflected from a large group of the needles at once, and they are seen when magnified to be in juxtaposition, and forming each group for itself an aggregate crystal, the lines of junction being represented in the larger crystals by the striation parallel to the long axis. At times the little groups ran under each other, or joined at their ends under angles of 80° and 100° , as if there were some trace of twinning on ∞P , as in the spindle-shaped crystals described later. It seemed like a model of the complex striation seen in the latter.

The prehnite also occurs in many drusy cavities covered with small distinct crystals, pale green, emerald green to yellow, and in delicate emerald-green "roses" produced by the multiple twinning of the same form $0P$, $\infty P\bar{\infty}$, $\infty P\infty$, and in stout, square prisms with base and two sides convex, the two remaining sides concave. The more common botryoidal forms are scarcely represented.

By far the most abundant, finely crystallized, and peculiar form is a stout double cone or spindle, the two cones joining directly base to base with an angle of 80° , or separated by a cylindrical plane, which may become as wide as the conical faces by which it is bounded; rarely this face is replaced by a reëntrant angle of 41° . These three faces are physically unlike, the two sloping ones being sometimes smooth and polished, at others mosaic-like, the equatorial plane being oftentimes milled as regularly as a coin by the oscillatory repetition of ∞P and $\infty P\bar{\infty}$, and finally the conical faces become rarely convex in the direction from the apex to the base, producing small, globular forms. These cones are laid usually with their axes parallel to the surface on which they rest—the axes pointing in all directions in this plane—and fused together so that only a fraction of each one is distinct, though they often stand out so that half or three-quarters of the circumference is visible, and in this way completely cover broad surfaces with a splendid crystallization. In color they range from white and nearly pellucid to pale celandine green, and rarely to pale rose color, in the smaller spindles with polished sides, to deep, clear apple green in the largest cones; and in other forms with very broad cylindrical faces, deep mountain green. Several pieces a foot square were obtained covered with the finest crystals. In a single instance the crystals of this form have spread over calcite, and, this having been removed, they presented a group of scarcely adhering individuals, the segments of cones bounded below by a single saddle-shaped face.

1882. **Prehnite**—Continued.

The internal structure of these crystals is quite peculiar. The pearly basal cleavage passes inward in the direction of a vertical section of the cone, and plates cut in this direction and continued down into the trap show the fibrous prehnite at the base felted together with much decomposed trap, above growing purer and forming distinct crystals with doubly striated cleavage faces, which are twinned along a distinct suture and bounded outwardly by irregular planes of contact. After each crystal has risen above the general level to form the segment of a double cone, the suture forks with an angle of about 41° , and the two lines run to meet the angles formed by the meeting of the two conical faces with the central zone. Each of the spindles is thus made up of three crystals, one on either side of and one within the angle of the Y-shaped suture.

The shaded portion of fig. 2 represents such a vertical section, in which $D o'$ and $D o''$ ($= \infty P \tilde{\infty}$) are the sections of the two conical faces and $o' o''$ ($= \infty P \tilde{\infty}$) that of the central cylindrical face.

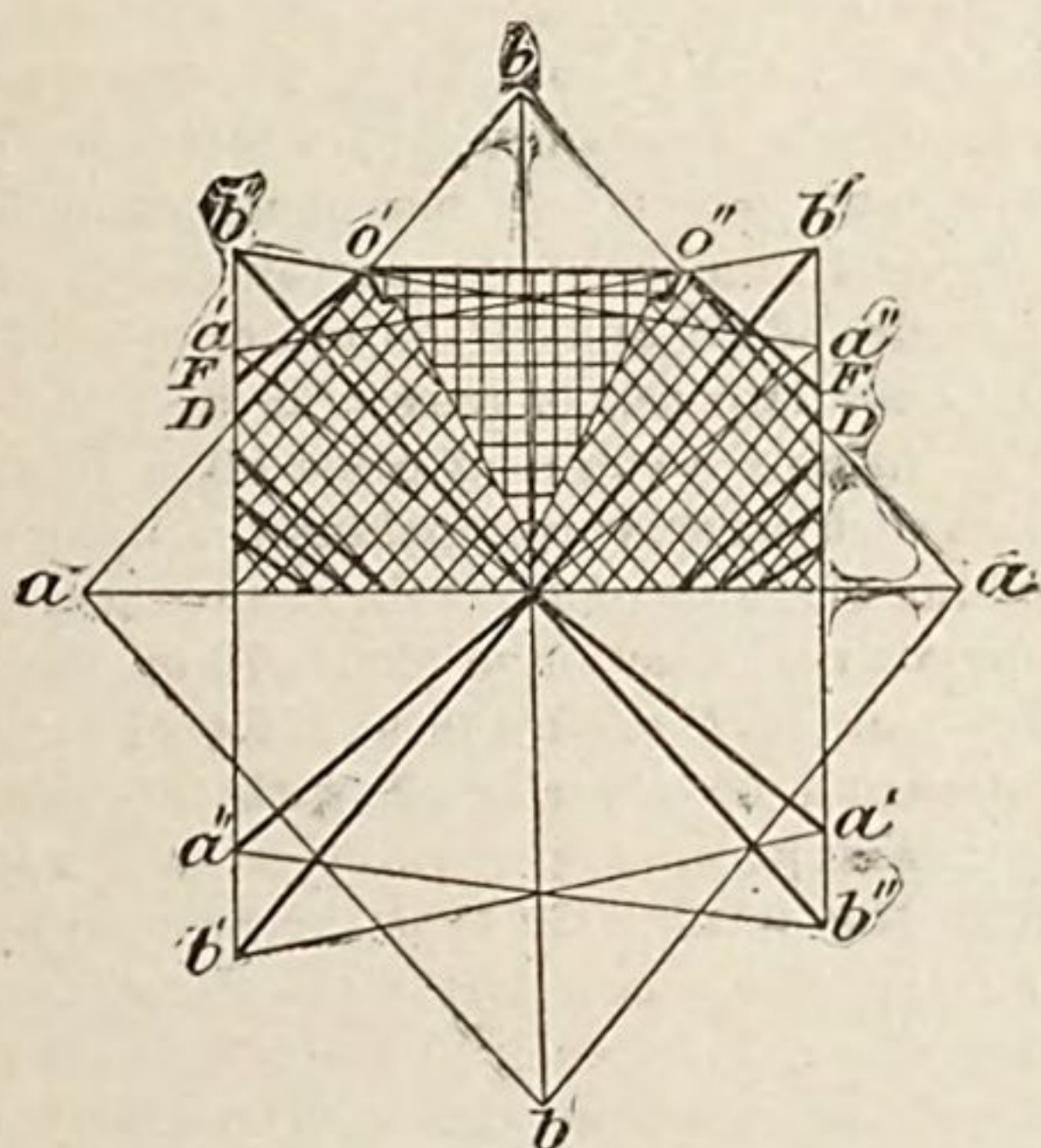


FIG. 2.—Prehnite; cross-section of twins.

The relations of the three crystals are made clear by fig. 2. Three superimposed prisms, ∞P , having the base $0 P$ in common are revolved on the common vertical axis c to right and left until a prism face of each becomes parallel to the long horizontal axis of the third. Thus the two lateral crystals form an arrow-headed twin with a face of ∞P in common, and are twinned against the middle one so that the same face ∞P in each is parallel with $\infty P \tilde{\infty}$ of the latter. If now the obtuse angle of the two lateral forms be truncated by $\infty P \tilde{\infty}$ and that of the central one by $\infty P \tilde{\infty}$ down to their point of contact o' and o'' , a plane, marked with a heavier line in the figure, results, by whose revolution on the short axis $a-a$ the spindle-shaped twin would be formed. The central crystal has the form of a triangular belt fitted into a similar groove upon the circumference of a wheel. An inspection of the figure will show that the arrow-headed twin, if formed by the union of two crystals having only the faces ∞P and $\infty P \tilde{\infty}$, would leave for the third crystal only an extremely shallow reëntrant angle of 160° , whereas the latter penetrates between the two in an angle of about 41° . This is because the acute angles of the lateral crystals are each replaced by the form $\infty P \tilde{3}$, giving a reëntrant angle of $43^\circ 17'$. The

1882. **Prehnite**—Continued.

approximated faces of this form are alone strongly developed and make a trumpet-shaped cavity for the reception of the wedge. The curved basal face in the free crystals mentioned above were formed by the blunt point of the arrowhead and by the corresponding faces of $\infty P \bar{3}$ on the outer acute angles below at a'' and a' . The tendency of the mineral to form these strange triplets seems to depend upon the greater intensity of the crystallizing force in the direction of the long horizontal axis, so that of the many crystals which start in the fibrous base only a few survive and grow up into the free space by preponderating additions to the face $\infty P \bar{3}$ at right angles to the long axis, and are soon twinned so as to allow a third crystal to wedge in between them and grow by the development of the same face. All three grow thus predominantly in the same direction and expose and add to only the single crystalline face, and the crystal expands in growing like the top of a growing tree. The common vertical axis of the three crystals is bent thus into a circle.

When examined under the polarizing microscope, the central crystal, though showing a strong vertical and a faint horizontal striation, acts as a single crystal. The two flanking crystals present through a whole revolution under the nicols a complex latticework of brilliant colors with two predominant positions of maximum extinction, or rather of extinction of the greatest number of the narrow bands and wedges of color in the field, at angles of 40° and 50° on either side of the suture—that is, when parallel to the two sets of axes $a' b'$ and $a'' b''$ of the two lateral crystals. The narrow wedges of color often repeated many times, placed parallel to each other, extinguishing the light together, and bounded by lines making an angle of 10° with each other, are especially peculiar.

Of course the extinction of the light on the right hand of the suture parallel to the axis b' can alone be referred to the right-hand crystal, and the extinction at an angle of 10° with this and on the same side of the suture—that is, parallel to the axis a'' of the left-hand crystal—must be referred to this latter. So that the twin is not formed simply by the approximation of the two parts along the common suture plane, but by the interpenetration also of each by the other in narrow and, as it were, interwoven bands, as is represented schematically in the figure—much more regularly, of course, than in nature.

The two principal striations in each of the lateral prisms make an angle of 40° with the central suture—that is, an angle of 80° with each other.

It follows, taking the prism on the right (fig. 2) for example, that while one of these striations is parallel to the long axis b' of this prism, the other is parallel to the long axis b'' of the opposite, and in fact both striations seem in the plainest manner to be continuous as right lines across the suture.

Traces exist also, very faint indeed, of two other sets of striations at right angles, respectively, to those already described, which are identical with the delicate horizontal lining of the central crystal, and which combined with those first mentioned produce the long wedge-shaped blades with angle of 10° described above. This second striation is indicated in the lower portion of the shading in fig. 2. The phenomena here detailed would seem also to find their explanation in the interpenetration of the lateral prisms.

The similar twins of prehnite from Farmington, Conn., which occur in the same Triassic trap as the Deerfield crystals, were figured by M. Des Cloizeaux,¹ and have been recently the subject of discussion by the

¹Min., p. 451, Atlas XXIX, 167 bis, 1862.

1882. **Prehnite**—Continued.

same author¹ and by M. Mallard² because of their optical peculiarities. They do not seem from the descriptions to present the spindle shape, and in cross section they differ from the Deerfield crystals in one important particular.

In the Farmington crystals the sloping faces (*F* in fig. 2) make an angle of 100° with each other, and the termination of the crystal is thus bounded by a threefold repetition of the face $\infty P \infty$, while in the Deerfield forms the corresponding angle of the two sloping faces measured over the single exposed face of the central crystal is 80° (*DbD*, fig. 2), and the three faces have the formulæ $\infty P \infty$, $\infty P \infty$, $\infty P \infty$.

One may express the relation of the two very simply by saying that in the Farmington crystals the end of the arrowheaded angle twin having the reëntrant angle has its acute angles truncated by $\infty P \infty$ to form the sloping sides, while in the Deerfield forms the other end is developed, and the outer obtuse angles truncated by $\infty P \infty$, as in the annexed figure.

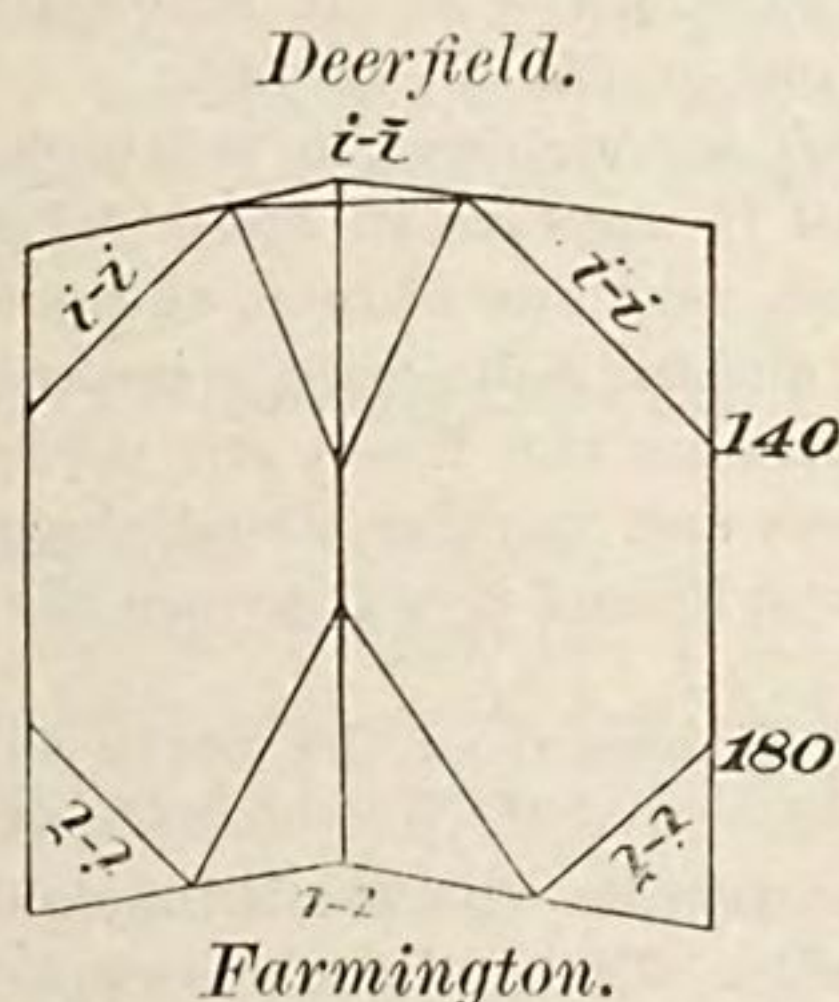


FIG. 3.—Prehnite; cross-section of twins; from fissures in Trassic diabase at Cheapside, Deerfield.

It seems to me simpler to say that the interpenetration of the two is so complex and at the same time so varying that in one case on the right of the suture the crystal which is turned to the right predominates and is truncated by $\infty P \infty$ (*F* in fig. 2), at right angles to b' , and in the other that which is turned to the left predominates on the same (the right) side, and determines the truncation by $\infty P \infty$ (*D* in fig. 2) at right angles to axis a'' ; while in the forms curved in the direction $o' a$, and in those with faceted faces, there is a gradual or interrupted transition from one to the other.

This would also harmonize very well with the complex optical results detailed in the above papers, and especially with the dispersion tournante signalized by M. Des Cloizeaux for the Farmington crystals.

If the sloping faces in the Deerfield crystals, like those of Farmington, be referred to the acute angles of the arrowhead, to recur to the first explanation given above, they would have the more complex formula $\infty P 6\frac{1}{2}$. Furthermore, the two well-marked striations described above form by their intersections diamonds with the acute angles (80°) at top and bottom, while the larger angle is at the sides, while the drawing of M. Des Cloizeaux³ shows the reverse to be the case in the crystals from Farmington.

¹ Bull. Soc. Min., Vol. V, Nos. 2 and 5, 1882.

² Ibid., No. 3.

³ Min.; *ibid.*, loc. cit.

1882. **Prehnite**—Continued.

That is, in the first they are parallel to b' and b'' (fig. 2), while in the second case, if they were exactly the reverse, they would be parallel to the short axes a' and a'' ; but they are stated in the later article of M. Des Cloizeaux to make an angle not of 80° , but of 82° , with each other, so that while one is parallel to a short axis the other is parallel to a hypothetical face, $\infty P 6$. If they made an angle of exactly 80° with each other, they would represent the horizontal striation of the central crystal and the faint second striation described in the Deerfield crystals, as slightly indicated at the bottom of fig. 2. As it is, they are difficult of explanation.

In amygdaloid cavities.—The amygdules of the trap quite closely repeat in miniature the occurrence of the large fissures, but the peculiar changes the prehnite undergoes in the former case makes it needful to discuss separately its modes of appearance there.

In the coarse diabase it occurs compact, of a bright green, as if colored by copper. The paragenesis is (1) diabantite; (2) chalcopyrite, pyrite, galena, prehnite, one or all; (3) calcite.

In the red diabase so abundant in the upper part of the dike through Greenfield and Gill it appears in spherical and spheroidal balls 12 to 15 mm. in diameter, very fine fibrous, and satiny, and very pale green to colorless; coated, and for a distance is impregnated with diabantite. It is radiated, fine fibrous, the fibers not easily separated, and diverging from several centers and meeting along sharp suture lines, so that only parts of spheres result, and if waterworn the grains would form perfect chlorastrolites.

In the dark-gray diabase from the north side of the Deerfield, and on through Greenfield and Gill, cavities 10 to 35 mm. across are sometimes filled with fibrous prehnite, the whole blackened as if it had been held in the flame of a candle. Under the microscope the fibers are, for the most part, perfectly fresh, and up through the spaces between them has penetrated a black amorphous powder looking like the beard of iron filings on a magnet, or like a network of soot-covered cobwebs. The whole seems to be dendritic in character.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 269.

1882. **Prehnite.** Bernardston.

Small compound crystals made up of several prisms surrounded by a dome and joined so as to make a form like a section of a thick saw blade, at the base of the upper quartzite of the Bernardston series; Williams farm.

1886. **Prehnite.** Northampton; at crossing of the Connecticut River Railroad, south of Mount Tom station.

In diabase; pale green, botryoidal.

1886. **Prehnite.** Northampton. At a quarry near W. N. Moore's, east of Florence.

In granite; a vein 10 mm. thick has on either wall quartz combs; on these broad sheets of finely crystallized prehnite, the crystals simple, 10 mm. long; forms $0 P (001)$, $\infty P (110)$, $\infty P \bar{\infty} (100)$, $\infty P \infty (010)$; often rosetted by continuous twinning around the vertical axis. For paragenesis see monograph on the geology of the area.

1886. Prehnite. Prescott.

North part, roadside west of old cemetery, in fissures in diorite.

Pearly white, in drusy surfaces of minute plates like Des Cloizeaux, Pl. XXVIII, p. 165; $0\ P$ (striated parallel to $\infty\ \bar{P}\ \infty$), $\infty\ P$, $\infty\ P\ \infty$, $\infty\ P\ \infty$, $3\ P\ \infty\ P$; plane of optical axes $\infty\ P\ \infty$; divergence 76° , positive; also covering broad surfaces with radiated fibrous circles 8 to 10 mm. in diameter, like wavellite, and in stout, fasciculate groups of crystals of forms like fig. 166 of the above plate, $0\ P$, $\infty\ P\ \infty$, $\infty\ P\ \infty$, $P\ (?)$.

An imperfect analysis made in the chemical laboratory of Amherst College gave results agreeing well with prehnite, except in the water determination. Mr. G. G. Pond, assistant in the laboratory, determined the water with care to 5.24, exactly that of prehnite.

1889. Prehnite. Monson.

In a vein in the northwest of Flynt's quarry; drusy surfaces of minute, transparent, colorless blades, $0\ P$, $\infty\ P\ \infty$, $\infty\ P\ \infty$, $\infty\ P$, flattened on 0 and elongate parallel to a , as determined by fixing the position of the optical axes, associated with epidote, actinolite, and clinochlore, which it follows. It is covered by a transparent calcite and later fine green rosettes and barrel-shaped groups of prehnite with laumontite and calcite, shows the richest green color.

PROCHLORITE.

1823. Chlorite. Hawley and Plainfield.

Abundant and extremely beautiful.

J. Porter: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VI, p. 248.

1823. Chlorite. Leyden and Conway, foliated. Millers Falls in Montague, penetrating milk-white quartz; New Salem.

E. Hitchcock: Geol. Conn. River; *ibid.*, p. 228.

(The occurrence at Millers Falls is probably in boulders, as the unaltered Triassic sandstones do not contain chlorite.)

1824. Chlorite. Middlefield and Chester.

In small masses; also in mica-slate (Emmons).

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 52.

1825. Chlorite. Zoar.

Abundant.

H. W. Wells: Robinson's Cat., p. 78.

1889. Prochlorite. Blandford, Whately, Northfield.

Occurs in quartz veins at contact of granite and hornblende schist near Bartholomew's quarry, in Blandford. In quartz veins in the argillite at Whately, and in the Devonian mica-schist in West Northfield. As a constant constituent of the sericite-schist across the whole width of the State. It is here largely derived from garnet.

PYCNITE.

See Topaz.

PYRITE.

1818. Sulphuret of iron. Charlemont and Deerfield.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 115.

1823. Sulphuret of iron. Hawley.

Small but beautiful crystals.

J. Porter: Min. Loc.; *ibid.*, Vol. VI, p. 248.

1823. Sulphuret of iron. (Pyrites. Iron pyrites.) Bituminous shale.

Westfield, Sunderland, Plainfield, limpid quartz. Hawley, compact. Montague, with hematite. Southampton lead mine, fine crystals as large as shot; octahedrons truncated in all their angles.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 232.

1841. Sulphuret of iron.

In mica-slate. Heath, handsome cubic crystals. Hawley, massive, in considerable quantity near junction of mica and talcose slate. Loudville, small octahedra truncated on angles.

E. Hitchcock: Geol. Mass., pp. 607, 705.

1844. Iron pyrites. (*Pyrites cubicus*.) Hawley, Heath.

In handsome crystals.

J. D. Dana: Sys. Min., p. 479.

1884. Pyrite. Rowe.

Ore of Davis mine.

Fe, 42.83; S, 50.30; Cu, 3.07; granular.

G. Lunge: Dingl. Polyt. Jour., CCXLIX, p. 48.

1887. Pyrite. Heath.

The vein of iron pyrites on the old Chester Rice farm at Heath, now owned by J. W. Tinkham, has been distinctly traced, and is on the surface about 5 feet wide by about 12 feet in length. There is thought to be a rich mineral pocket beneath the indications.

Springfield Republican, 1887.

1891. Pyrite. Heath.

A ledge of rock thickly sprinkled with pyrites of iron 3 to 4 feet wide and 12 or more in length has been discovered in a ravine on the Tinkham farm. A small stream runs over the rocks, which when broken with a sledge disclose the pyrites, bright and shining.

Springfield Republican, February 24, 1891.

1891. Pyrite. Rowe.

The Davis mine in Rowe has furnished the largest amount of pyrite of any locality in the State, and is perhaps the only profitable mine in the State. The mineral is abundant everywhere in the Hawley schists. An especially fine deposit occurs south of Forge Hill, in Hawley. The deposits are of greater geological than mineralogical interest.

PYROCHLORE.

See Microlite, which was claimed to be pyrochlore.

PYROLUSITE**1824. Oxide of manganese.** Plainfield.

"Yielding vital air in abundance."

Dr. J. Porter: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VII, p. 252.

1824. Black oxide of manganese. Cummington, near Plainfield.

Cummington; compact and earthy. Also two localities of the compact variety of this ore west of Plainfield; in great abundance and of excellent quality.

Same; *ibid.*, Vol. VIII, p. 233.

1824. **Black oxide of manganese.** Plainfield.

"Dr. Porter, of Plainfield, sent me what he calls iron ore. I have lately ascertained that it is manganese; Cummington or Plainfield."

E. Emmons: Loc. Min.; *ibid.*, Vol. VII, p. 254.

1824. **Oxide of manganese.** Cummington.

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 57.

1827. **Manganese.** Conway.

In quartz vein 2 or 3 miles southeast of the meetinghouse.

A. Nash: Lead mines of Hampshire County; *ibid.*, Vol. XII, p. 255.

1835. **Oxide of manganese.** Conway.

In a vein of jaspery quartz 6 to 8 feet thick; dip, 90° ; strike, north 20° east; in southeast of Conway with hematite.

Same in numerous boulders in Amherst 1 mile northeast of the college.

E. Hitchcock: Geol. Mass., p. 344.

1841. **Oxide of manganese.** Plainfield.

One mile west of Center and near southwest corner. Associated with rhodonite; mined for iron. Conway, southeast part; distinct vein in quartz, several feet wide.

E. Hitchcock: Geol. Mass., p. 205.

1841. **Pyrolusite.** Plainfield.

Several beds occur near one another at two principal places represented on the map; smaller and larger beds occur within a few feet of each other. The beds are rarely more than 3 or 4 feet thick. Apparently common pyrolusite. On breaking open the mass they are found to be of a beautiful rose red—the bisilicate of manganese of Dr. Thomson. Many blocks in wall northeast of the church in Cummington, in talcose slate.

E. Hitchcock: Geol. Mass., p. 612.

(This refers to the black decomposition products of the rhodonite.)

1878. **Pyrolusite.** Amherst. Boulders.

Very fine specimens found by J. M. Clarke in yellow jasper, doubtless from Conway.

1879. **Pyrolusite.**

Films of pyrolusite in cleavage cracks of spodumene derived from decomposition of garnet.

A. A. Julien: Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 319.

1881. **Pyrolusite.**

Large boulder; cavernous quartz with pyrolusite found by H. B. Patton, class of 1881, Amherst College, on east end of Holyoke range.

PYROMORPHITE.

1835. **Phosphate of lead.** Southampton.

Spherical light-green masses.

E. Hitchcock: Geol. Mass., p. 508.

1841. **Phosphate of lead.** Southampton.

Spherical light-green masses.

Ibid., p. 705.

1879. **Pyromorphite.** Leverett, south mine.

Pseudomorphs of pyromorphite in small hexagonal prisms $\propto$ P, 0 P. Thin films of silica containing a pulverulent mixture of limonite and a carbonate.

1885. Pyromorphite. Loudville.

The finest specimen I have seen is in the Kunz collection, purchased by Amherst College. It is a large mass of quartz, covered with crystals which rival those from Phoenixville in beauty. The quartz agrees exactly with the Loudville gangue.

1887. Pyromorphite. Loudville.

In large, thick coatings and drusy surfaces; also in a fine, brown coating on quartz, and covered by wulfenite. Occurs coating quartz in broad faces; small botryoidal, fine and rare.

In Clark collection of Smith College.

PYROPHYLLITE.

1876. Pyrophyllite. Leverett lead mine, North Leverett.

Pale-green, compact layer 1 to 3 mm. thick on dark-gray veinstone, which consists of blue quartz and some clearly cleavable glassy feldspar, with much barite in the mass; gives blue color with cobalt, swells and whitens and fuses with difficulty. $H. = 3$. Greasy feel, brittle, fibrous in places.

PYROPE.

See Garnet (1823).

PYROPHYSALITE.

See Topaz.

PYROXENE.

1824. Augite. Chester and Middlefield.

Abundant in amorphous masses; sahlite and coccolite.

E. Emmons: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VII, p. 255.

1824. Augite. Chester.

Greenish-gray, brown, yellowish, tending to crystalline forms; also beautiful white augite finely granular or compact; foliated with considerable luster.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 48.

1825. Pargasite. Chester.

Short, green crystals with idocrase and epidote.

E. Emmons: Min. Not.; *ibid.*, Vol. X, p. 11.

1825. Augite. Chester.

Abundant in amorphous masses. Sahlite and coccolite in beds in mica-slate well characterized. Found also in Middlefield in above varieties.

Robinson's Cat., pp. 42, 59.

(I have not been able to verify the above citations. The augitic sienite mentioned below is a pyroxene hornblende contact rock upon the granite, and the pyroxene is in broad grass-green blades.)

1835. Augitic sienite. North part of Belchertown.

Augite and feldspar, boulders, in Amherst (Nos. 1362, 1363 in State collection).

E. Hitchcock: Geol. Mass., p. 455.

1835. Augite. Pelham.

With feldspar, actinolite, and sphene.

Ibid., p. 398.

1835. **Augite.** Williamsburg.

Augite rock. Granular greenish-yellowish, mixed with quartz interstratified with mica-schist and hornblende-schist, 2 miles west of the meetinghouse. Nos. 226 and 227 in the State collection. Also at Chester (Emmons).

Ibid., p. 330.

Wanting in the State Collection.

1841. **Augitic sienite.**

"The presence of hornblende in this rock and the absence of mica have led me to call it augitic sienite rather than augitic granite, although in position it is associated with granite. There are two varieties: First, black hornblende, greenish augite, and yellowish feldspar; all the ingredients, except the feldspar, exhibiting a very distinct and lively crystalline structure; this variety occurs in the north part of Belchertown. Second, augite and feldspar in boulders in Amherst, the former being so arranged in the latter as to present the appearance of letters."

E. Hitchcock: Geol. Mass., p. 669.

1876. **Augite.** Belchertown.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College.

1881. **Pyroxene.** Pelham.

Three fine pieces of a light-colored well-crystallized pyroxene in calcite from the asbestos mine, well terminated and complex, were destroyed with the Shepard collection.

Rarely in large, stout, pale-green prisms in Pelham gneiss.

1887. **Augite.**

Occurs as a characteristic constituent of the Triassic diabase, usually microscopic, but at Titan's Pier in black curved plates several millimeters across.

1887. **Diallage.** Hatfield, Belchertown.

Occurs as a characteristic element of the Hatfield and Belchertown tonalite; in the former almost always, in the latter largely, changed to hornblende, so that it is possible that it is the source of all the hornblende; most abundant in large crystalline grains near S. and A. Craft's, Belchertown.

PYRRHOTITE.

1841. **Hepatic sulphuret of iron.** Middlefield.

In bitter spar, in serpentine. In talcose slate.

E. Hitchcock: Geol. Mass., p. 613.

1886. **Pyrrhotite.** Charlemont.

The pyrite occurring in a vein in gneiss is described as made up of pyrrhotite and true pyrite.

A. A. Julien: The decomposition of pyrite; Ann. N. Y. Acad. Sci., Vol. III, p. 398.

1891. **Pyrrhotite.** Chester.

In large, nodular masses at the emery mine. In colorless diaspore with rutile and corundophyllite.

QUARTZ.

1810. **Quartz.** Southampton lead mine.

Numerous crystals, usually very regular, sometimes large, and often so beautiful and brilliant that the cavities look as if studded with gems. Many are sufficiently perfect to deserve a place in the choicest cabinets.

B. Silliman: Bruce's Min. Mag., Vol. I, p. 64.

1818. **Quartz.**

Rock crystal, Conway, on feldspar (description); irised quartz, Leyden; granular quartz, Deerfield; radiated quartz, Whately and Shelburne; blue quartz and greasy quartz, rolled masses on banks of Deerfield River; pseudomorphous quartz, lamellar quartz, tubular or pectinated quartz, in greenstone, Deerfield; geodes and prase, North Sunderland (poor); amethyst, in greenstone, Deerfield; chalcedony, carnelian, cacholong, sardonyx and agate, in greenstone, Deerfield (described); jasper, Deerfield River and Leyden (arrows). Petrosilex (poor), same. Rose quartz, boulder, Deerfield.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, pp. 112, 113.

1823. **Basanite.** Deerfield.

In alluvial soil on the banks of the Deerfield River, perhaps brought by aborigines.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 220.

1823. **Quartz.**

Blue quartz, Cummington. Rose, beautiful and abundant, east part of Chesterfield. Irised, abundant, Chesterfield. Red, yellow, orange, from film of metallic oxyd, greasy, Plainfield. Arenaceous, Plainfield and Cummington; abundant, burnt and crushed for sand. Stalactitic, at falls of brook in Middlefield. The crystals, which are small and have a light tinge of red, are formed on serpentine, evidently in a manner similar to that of stalactites. The specimens are of singular beauty (Emmons).

J. Porter: Loc. Min.; *ibid.*, p. 247.

1823. **Quartz.**

Fetid, Cummington; chalcedony, Middlefield.

Milky or reddish-white with blood-red spots; cavities lined with minute and beautiful crystals, sometimes blood red, generally white or bluish (Emmons). Hornstone, Middlefield (Emmons). Agate, Chester (Emmons).

J. Porter: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VI, p. 248.

1823. **Quartz.**

Limpid, Plainfield (J. Porter). In lead mines in veins in Southampton and Leverett, and in copper veins in Greenfield, here doubly terminated. In sienite in Northampton. Greenstone, Deerfield, in veins and geodes 1 to 10 inches wide. In mica slate in Conway; crystals one-tenth to 2 inches wide, in vast quantities. In Conway fragments as transparent as quartz from Madagascar. Smoky, Plainfield. Yellow, Southampton lead mine. Honey-yellow, resembling Siberian topaz, rarely at Leverett. Irised, Plainfield (J. Porter). Leyden, in mica slate. Milky, Cummington and Plainfield (J. Porter), poor. Radiated, Southampton, Whately, Leverett (in lead), Conway. Lamellar, greenstone, Deerfield; usually parallel; thin, brittle, sometimes intersecting. Conway, large, loose masses in mica-slate above 1 foot in diameter; plates often drusy, grades with common quartz. Pseudomorphous, cubes, Southampton lead mine. Deerfield in greenstone; also, at Deerfield, cavities with radiated arrangement, flattened, four-sided prisms one-half to 4 inches long (zeolite?).

Amethyst, Mount Tom (Silliman), Deerfield; geodes, light purple, one-tenth to 1 inch.

Chalcedony, Hadley, Sunderland, Deerfield, Gill, and in almost every greenstone hillock and ridge from New Haven to Gill (description).

Chacolong, carnelian, sardonyx, agate, Deerfield; in greenstone with chalcedony.

1823. Quartz—Continued.

Since the publication of previous accounts Dr. Dennis Cooley has discovered a new locality in the Deerfield greenstone, from which he has obtained specimens so much superior to these heretofore found that they deserve particular notice. Six specimens are described. No. 1 is without chalcedony; another, with amethyst, weighs 23 pounds. Others are described as fortification and ribboned agate, and spoken of as of the first quality.

Hornstone, Southampton lead mine; Conway. In greenstone in Deerfield and Sunderland; nodules 4 to 5 inches in gray-green, black, reddish, and dark-blue; fracture little conchoidal and glistening or dull and splintery, nearly opaque; some specimens resemble siliceous slate, others prase. Professors Silliman and Dewey, the latter of whom has examined it chemically, agree in calling it hornstone.

Jasper, Cummington, banks of Westfield River (J. Porter); banks of Deerfield River in Deerfield. Conway, Leyden, rolled, red, black, and yellow.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, pp. 214-219.

1824. Plasma. Pelham.

The most interesting mineral from Pelham is one which is undoubtedly a subspecies of quartz. It strongly resembles chalcedony; it preserves but little luster; its fracture is nearly even, somewhat splintery and flat-conchoidal; it breaks readily under the blow of the hammer into large, indeterminate, sharp-edged fragments, sometimes exhibiting concretions; its color is leek-green, uniformly diffused excepting occasionally small whitish dots which are distributed through the mass at nearly equal distances; it is translucent. Before the blowpipe it loses its color and becomes white. Should it belong to the subspecies chalcedony it is the variety called plasma, which has not been found hitherto in the United States. It was discovered in digging a cellar in a rounded mass upward of 2 feet in diameter.

C. U. Shepard: Min. Loc.; Am. Jour. Sci., 1st series, Vol. VIII, p. 235.

1824. Laminated quartz. Cummington and Plainfield.

Both milky and smoky. Jasper; blue in brook in Worthington.

J. Porter: Loc. Min.; *ibid.*, p. 233.

1824. Quartz. Middlefield.

Minute pyramids in cavities in serpentine (Emmons). Smoky, banks of streams. Rose, Chester, in granite. Irised, rolled masses, beautiful, Middlefield (Emmons). Greasy, Plainfield (Porter). Tabular, Middlefield. Blue, Cummington (Porter); grayish blue, differs little from the smoky.

Laminated; new variety, Chester (Emmons); distinctly laminated, folia separate by a blow like those of calcareous spar; partially translucent; faces not smooth, and marked by oblique striæ.

Amethyst, in trap, West Springfield (Emmons). Ferruginous, fetid, chalcedony, in Middlefield in serpentine.

Hornstone, dark-blue in Middlefield in serpentine (Emmons).

Agate, Middlefield and Chester; ground-yellow jasper with bands of bluish white; one weighed 200 pounds; it seems one vast agate made up of a multitude of smaller ones.

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 37.

1824. Quartz.

Yellow crystals, Worthington. Fetid, Chesterfield. Chalcedony, Cum-
mington. Jasper, red, banks of the Westfield River in Cummington.

J. Porter: Loc. Min.; *ibid.*, Vol. VII, p. 253.

1824. Agate. Near Chester.

"Weight upward of 180 pounds; yellow jasper and chalcedony—a
large mass of chalcedony and jasper which is in part agatized. I have
since seen not far from the village a mass almost twice as large as the one
mentioned above." (Came from the serpentine.)

E. Emmons: Loc. Min.; *Am. Jour. Sci.*, 1st series, Vol. VII, p. 256.

1825. Quartz.

Plainfield, blue, good color. Shelburne, radiated.

J. Porter: Loc. Min.; *ibid.*, Vol. IX, p. 54.

1825. Quartz (after calcite). Williamsburg.

"This mineral has the form of hogtooth spar incrustated with very minute
crystals of quartz, but on breaking it it is found to be hollow with larger
crystals at its base, or in some few instances it is wholly filled up with
semicrystalline quartz."

Hampshire Gazette, July 14, 1824. Quoted by J. Porter in *Min. Not.*;
ibid., Vol. IX, p. 54.

1825. Quartz. Chesterfield.

Crystallized in the form of the primary rhombohedron in feldspar; dull,
one-fourth inch long, lateral edges usually truncated.

C. U. Shepard: *Bost. Jour. Phil. and Arts*, Vol. III, p. 608.

1825. Quartz.

Amethyst, Mount Tom; beautiful crystals. West Springfield (see *Am.*
Jour. Sci., 1st series, Vol. VIII, p. 38.) Flint, in bituminous shale of coal
formation. Blue jasper, Worthington, margin of brook (J. Porter). Chal-
cedony, Amherst; in rolled masses, of fine blue color in a brook.

Robinson's Cat., pp. 35, 65, 74, 78.

The latter was in boulders from Conway.

1825. Amethyst. Belchertown.

In a rounded mass about 18 inches in diameter, composed of imperfect
prismatic crystals of extraordinary size which shoot out from a quartz
gangue containing galena, blende, and copper pyrites. Many of these
crystals terminate in regular pyramids at the surface, but just previous to
their termination the amethyst passes through them in a vein from 1
to 2 inches in width, and below the vein are zigzag striæ of milky quartz,
which render many of the crystals very beautiful.

C. U. Shepard: Loc. Min.; *Am. Jour. Sci.*, 1st series, Vol. IX, p. 47.

(Specimens in cabinet of Amherst College.)

1825. Quartz.

Announces the discovery of a new mass much larger than the one first
found of the Pelham prase. (Plasma, above, 1824.) It is more uniformly
colored, does not have whitish and yellowish spots distributed through it,
and is of a deeper color; in a single place it passes into common quartz.
"I think there is no doubt of its being the hornstein eccailleux of
Brochant."

C. U. Shepard: Loc. Min.; *ibid.*, p. 47.

1825. Quartz (after fluor). Westhampton.

"The quartz is formed in the vicinity of the argentite; some of these
projections are rectangular; perhaps these were formed upon crystals of

1825. **Quartz** (after fluor)—Continued.

sulphuret of lead, as some lead is found in the rock. We have found but a few of the cubic projections. The dogtooth formation is found in abundance." (The cubes show the twinning of fluor.)

Letter of Mr. Morris Dwight; Am. Jour. Sci., 1st series, Vol. IX, p. 176.

1825. **Quartz** (after calcite). Loudville mine.

Hexahedral prisms with trihedral summits grouped in cavities in quartz, one-half inch in diameter; brownish-yellow, drusy.

C. U. Shepard: Min. Loc.; *ibid.*, Vol. IX, p. 249.

1825. **Amethyst** (in greenstone). West Springfield.

Emerson Davis: Min. Not.; *ibid.*, p. 252.

1826. **Tabular quartz**. Palmer.

Of a wine-yellow color, found in abundance in Palmer at the site preparing for the new factory at Three Rivers. The crystals may be obtained in large groups, well defined, and embedded in coarse granite.

Anon: Chem. and Min. Jour., Vol. I, p. 78.

1826. **Quartz**.

Stalactitical, Middlefield, Cummington, Worthington. Radiated quartz, covered with crystals, Goshen and Williamsburg. Blue jasper, in branch of Westfield River, Chester.

J. Porter: Min. Not.; Am. Jour. Sci., 1st series, Vol. X, p. 18.

1835. **Quartz**.

Amethyst. One mile east of Deerfield, 3 miles south and east of Bloody Brook. Mount Holyoke and West Springfield—here smoky. Tabular, 1 mile east of Deerfield. Chalcedony, gray and yellow, east of Deerfield, and Greenfield on west side; rare on east side of the mountain. Agates usually small; those found by Dr. Cooley, 2 miles northeast from Bloody Brook meetinghouse (South Deerfield), 9 by 6 inches; weight, 23 pounds; outside green one-half inch, then flesh colored, then amethystine (No. 1191). Fortification agate. Chalcedony is also found in the Middlefield serpentine, and it sometimes passes into hornstone. Large rolled masses of these minerals, often agatized, have been found in Middlefield and Chester, which probably proceeded from some serpentine locality. Also in the same, serpentine drusy quartz of extreme beauty.

Pelham. In boulders scattered over several acres; fine crystals, limpid, commonly light-brown to fine topaz-yellow, rarely amethystine, 2 inches in diameter; with this, fine chalcedony milk-white to delicate olive.

E. Hitchcock: Geol. Mass., pp. 371, 399, 435.

1841. **Quartz**.

Nearly all the preceding localities cited; also Whately; delicate crystals in sienite, druses with blade-like cavities from removal of crystals (barite). Pelham, south part; crystals in large quantity, some of which will answer for the lapidary; hornstone (Shay's flint), mass presented by O. M. Clapp to E. Hitchcock. Goshen, crystals of smoky quartz. Blandford, Chester, Chesterfield, Williamsburg, rose quartz. Southampton, Westhampton, pseudomorphs after calcite and fluor. Mount Holyoke, amethyst; also Amherst, in rolled masses. Conway, southeast part, vein 6 to 8 feet of brown and yellow jasper and black, brown, white, red, and yellow chalcedony, rarely banded agate; whole often brecciated; with hematite and pyrolusite; same abundant in boulders in Amherst.

E. Hitchcock: Geol. Mass., pp. 186, 604, 700.

1844. **Quartz**. (*Hyalus rhombohedrus*). Pelham and Chesterfield.

Yellow jasper. Chester.

J. D. Dana: Sys. Min., p. 412.

1859. **Crystallized quartz.** Norwich. Angell's mine.

E. Hitchcock: Cat. State Geol. Cab.; Rep. Agri. Mass., Vol. VI, App. LXIX.

An examination of these specimens which are contained in the collection deposited at Amherst College shows that they are beautiful pseudomorphs after calcite— $\frac{1}{2}$ R, and that the broad, flat plates from 1 to 3 inches square and of drusy surface are pseudomorphs after barite.

1876. **Quartzite.**

Name proposed in place of quartz.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst, p. 6.

1879. **Quartz.** Chesterfield Hollow.

Pseudomorph after spodumene, very rare, 6 to 9 inches long, sharply defined, not terminated.

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 350.

1882. **Hornstone.**

In abundant half-inch veins in a layer of decomposed gneiss with laumonite, north end of Monson quarry; leek-green.

1882. **Quartz.** Deerfield.

Only in a single specimen from the Cheapside veins did quartz appear associated with the zeolitic minerals. Here a few minute, elongated prisms appear in and on prehnite. Toward the upper surface of the dike occur veins 4 to 5 cm. wide—coarse, comby quartz, whose terminations interlace irregularly at the center. Between the wall on one side and the regular cockscomb quartz, a layer 10 mm. thick of broken-up quartz crystals, recemented by quartz, showing that the vein had once partly filled itself and then by the rubbing together of the walls the work was interrupted. In other parts of the vein the quartz is much gashed by broad, thin cavities, which are often as many as twelve, one above the other, and parallel to the walls as well as scattered in various directions. They seem to have been produced by the repeated formation of a layer of some mineral, now wholly gone, probably selenite or barite.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 351.

1883. **Yellow jasper.**

Boulder in North Amherst, but doubtless from the vein in Conway (see 1841, above). Filled with spherical globules of hematite just visible with lens. Analysis by Mr. Wm. Orr, jr., class of 1883, Amherst College. Heated twenty-four hours on sand bath with KHO. Sp. gr. 1.20.

Analysis.

SiO ₂ (soluble).....	55.59
SiO ₂ (insoluble)	26.34
Fe ₂ O ₃	15.77
Mn ₂ O ₃	.62
	100.87

1885. **Quartz.**

In quite large crystals and fine drusy crystallizations, colorless and amethystine, rarely showing only tetrahedral faces. In many cases filled with minute (1 mm.) globules of hematite so orientated that over a broad surface all the crystals are filled on one side and looking from the opposite direction the globules are all invisible. In diabase south of Titans Piazza.

1885. **Chalcedony.** Chester.

Thick masses of amber color, fine botryoidal with stalactitic forms and incrustations of rootlets from the serpentine.

1885. **Agate.** Granby.

Veins 20 to 25 mm. thick of a fine, bluish-white agate occur in the fourth volcanic core east of the road running south from the Notch.

1894. **Quartz.** Warwick.

At the epidote locality at Crystal Hill, north of Hastings Pond, fissures in the epidote garnet rock are filled with long slender quartz crystal 5 to 6 cm. long, which project freely into the cavity, are transparent, and perfectly terminated with one terminal face predominant, as in the Dauphinée crystals.

1895. **Quartz.** (Pseudomorph after galena.) Southampton lead mine.

Hollow cubes, often a half inch across, often with parallel ridges on the inside, when the quartz penetrated into the cubical cleavage planes of the galena.

QUINCITE.

See Montmorillonite (1876).

RHODOCHROSITE.

1825. **Carbonate of manganese.** Cummington.

Flesh-color and rose-red, outside gray to black; recent fracture soon changes to dark color if exposed to moisture.

Effervesces sharply with acid in powder; NO_5 dissolves it entirely; before blowpipe browns; infusible. In large amorphous mass in many places in Cummington; has been called red oxide of manganese; by others siliceous oxide of manganese and gray oxide of manganese. All the specimens I have examined effervesce in acid.

E. Emmons: Am. Jour. Sci., 1st series, Vol. IX, p. 249.

1852. **Diallogite.**

A pulverulent pink variety coating triplite in granite; occurs at Goshen and Norwich.

C. U. Shepard: Min., 3d ed., p. 96.

1891. **Rhodocrosite.** Hawley.

Impregnating the fine granular quartz adjacent to the magnetite-hematite veins at the old mine on the Howes place (Forge Hill), and farther south on the vein in the Cressy pasture. It forms a flesh-colored sandstone which blackens rapidly.

1892. **Rhodocrosite.** Hawley.

The following analysis by Mr. L. G. Eakins, of the United States Geological Survey, represents the composition of the flesh-colored arenaceous rock from the mine of Mr. C. V. Cressy in the pasture just south of the road over Forge Hill.

Part soluble in HCl:

FeO	2.40
MnO	28.44
NiO	.02
CoO	Trace.
CaO	10.98
MgO	1.29
CO ₂	28.71
	71.84
Insoluble in HCl, nearly all quartz	26.68
	98.52

RHODONITE.

1824. **Siliceous oxide of manganese.**

Specimens obtained in Chesterfield, but exact locality not learned.

W. Meade: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VII, p. 54.

1824. **Siliceous oxide of manganese.**

Chesterfield, near the locality of sappare (kyanite), associated with green feldspar in granite.

C. U. Shepard: Loc. Min.; *ibid.*, p. 251.

(I have not been able to rediscover this locality, and doubt the occurrence of rhodonite in granite in the Conway schist.)

1825. **Oxide of manganese.** Cummington.

"In immense quantity one-half mile west of Congregational church on land of Mr. Packard. It would be an easy matter to collect at this locality 50 tons of the mineral. * * * I could not find the ore in place, though from the appearance of some specimens I have little doubt that they form a bed in mica-slate. [Suggests that the black coating is derived by oxidation from the pink.] Mr. Bryant, who lives near the spot, pointed out to me a specimen which had been broken a year or two since and which by simple exposure to the weather since that time had already become coated by a thin pellicle of the black oxide."

E. Hitchcock: Loc. Min.; Am. Jour. Sci., 1st series, Vol. IX, p. 22.

1825. **Siliceous oxide of manganese.** Cummington and Plainfield.

In considerable abundance.

J. Porter: *Ibid.*, p. 55.

1827. **Siliceous carbonate of manganese.** Cummington.

At junction of mica-slate and talcose slate, 2 miles north of the meeting-house in Cummington. Exposed in place, several feet wide, 15 to 20 rods long; black and gray oxide in abundance, and along with them there is a small vein of the siliceous carbonate also embedded in the black oxide; it was supposed to contain iron, and a forge was erected. The masses are found on the ground in the immediate vicinity of the vein and scattered clear across the town, and also north in Plainfield.

A. Nash: Lead mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 249.

(This must be the main opening at T. Williams's, which is $3\frac{1}{2}$ miles northwest of Cummington, as a point 2 miles north of Cummington would not be near the junction of the schists.)

1835. **Manganese spar.** Cummington.

C. U. Shepard: Min., Part II, Vol. II, p. 24.

1841. **Bisilicate of manganese.** Plainfield, 1 mile west of center.

"In beds of interstratified layers in talcose slate, rarely more than 2 to 3 feet thick; several of them occur near one another at two principal places represented on the map. Their surface is black or dark gray, apparently the common pyrolusite. In the interior beautiful rose red. Recently analyzed by Dr. Thompson and found to be bisilicate of manganese. In stone walls a little northeast of the meetinghouse in Cummington in numerous large blocks, probably transported thither from the beds above described. In talcose slate."

E. Hitchcock: Geol. Mass., p. 613.

1849. **Mangan amphibol.** (Hermann.) Cummington.

Hermann: Jour. Prac. Chem., Vol. XLVII, p. 7.

(The above name was based on an error and gave rise to the two following names.)

1853. **Hermannit.** (Kenngott.) Cummington.

A. Kenngott: Min., p. 71.

1860. **Cummingtonite.** (Rammelsberg.) Cummington.

C. Rammelsberg: Min. Chem., p. 473.

1868. **Rhodonite.** Cummington.

J. D. Dana: Min., p. 235.

1875. **Cummingtonite.**

"Soll eine Manganhornblende sein."

C. Rammelsberg: Min. Chem., 2d ed., Vol. II, p. 400.

1877. **Hermannit.** Cummington.

F. Zirkel (Nauman): Min., p. 606.

(The ancient error is still carefully preserved and Hermann's mangan amphibol cited.)

1885. **Rhodonite.** Warwick. Near Winchester and Hinsdale, N. H. Cummington, in boulders.

G. F. Kunz: Precious stones of the United States; Rep. Min. Res. U. S. for 1883-84, p. 766.

1888. **Rhodonite.** Cummington.

"The rhodonite so well known as occurring as boulders at Cunningham [sic], Mass., has recently been traced to the ledge, and we may now hope to see the rock used extensively for decorative and ornamental purposes, as at this locality it is one of the richest pink and flesh-colored minerals known."

G. F. Kunz: Precious stones, in Min. Res. of the U. S. for 1887, p. 562.

1889. **Hermannit.** Cummington.

Gröth: Tabell. Uebersicht d. Min., p. 134.

A persistent error (see 1849, above).

1889. **Rhodonite.** Cummington.

Polished specimens of thin-cut stones and a vase were shown in Tiffany's exhibition of gems at the Exposition in Paris.

G. F. Kunz: Private communication.

1890. **Rhodonite.** Cummington.

Announces the discovery of the ledge. "Fine masses weighing several hundred pounds have been blasted out, and an effort will be made during the coming year to introduce this as an ornamental stone."

G. F. Kunz: Gems and precious stones of the U. S.; Min. Res. of the U. S. for 1888, p. 582.

1891. **Rhodonite.** Cummington, Warwick.

"On Osgood's farm,¹ Massachusetts, and in the neighboring towns; in Warwick, Mass. The rhodonite of Cummington of the richest flesh and light-red color was found only in boulders previous to 1887, when it was traced to the ledge by W. W. Chapman. Blocks were taken out weighing some hundreds of pounds each, of a rich pink and red color, and with large surfaces entirely free from streaks of black oxide, and in other places beautifully mottled; they were equal in quality and beauty to the Russian rho-

¹ Cummington should probably be supplied here.

1891. **Rhodonite**—Continued.

donite, which is made into vases and also table tops and mantels. This material has been used very effectively in combination with unpolished or stone-finished silver as handles for very fine ornaments, the rose color streaked with black affording a pleasing contrast. Its hardness is only 6.5, but it is nearly as tough as jade.

G. F. Kunz: *Gems and precious stones of the U. S.*, pp. 151, 152

1891. **Rhodonite.** Cummington, Plainfield, Hawley.

I have given in the monograph on the geology of the region a full discussion of the long series of manganesian deposits situated on the fissure, extending from the old manganese mine near the south line of Plainfield, at T. Williams's, where it is exposed in great width, to the well-known mine of specular iron on Forge Hill, in Hawley, and have described the occurrence of rhodonite at many new points along this line. All the masses of the mineral found in Cummington are glacial boulders from Plainfield, and the reputed discovery of the ledge in Cummington has no basis in fact. A few large boulders were uncovered in a trench at the old locality and were supposed to be the ledge.

1892. **Rhodonite.**

"Occurs in Cummington and some of the neighboring towns in boulders; also in Warwick."

E. S. Dana: *Sys. Min.*, p. 380.

RHÆTIZITE.

See Cyanite, 1835.

RUTILE.

1812. **Oxide of titanium.** Worthington.

Dark-red crystal longitudinally striated; the surface splendid and somewhat iridescent; embedded in white, semitransparent quartz, part granular and part compact, which occurs in beds of hornblende slate. From Dr. John F. Waterhouse.

A. Bruce: *Bruce's Min. Jour.*, Vol. I, p. 237.

1818. **Red oxide of titanium.** Leyden, Shelburne.

At Leyden, on quartz and tremolite; brownish-red; sp. gr. 4.232; geniculated, sometimes several geniculations on a single specimen; in one, six.

E. Hitchcock: *Geol. Deerfield*; *Am. Jour. Sci.*, 1st series, Vol. I, p. 116.

1823. **Red oxide of titanium.** (Bruce.) Worthington.

"Leyden; in four- or eight-sided prisms, often handsomely geniculated, generally striated, in limpid quartz, tremolite, and hornblende. Some of the specimens have several geniculations and are as large as the thumb. Hundreds of good specimens have been collected at this locality.

"At Colerain and Shelburne I found it penetrating a vein of quartz in mica slate in place. In Conway a few small crystals have been observed exhibiting the primitive form and presenting the kind of twin crystal described in Rees's *Cyclopedia*, art. Rutile. May be found anywhere on a strip several miles wide between Conway and Brattleboro, Vt."

E. Hitchcock: *Geol. Conn. River*; *Am. Jour. Sci.*, 1st series, Vol. VI, p. 236.

1824. **Red oxide of titanium.** Cummington.

Dr. J. Porter: *Loc. Min.*; *ibid.*, Vol. VII, p. 58.

1824. **Ferruginous oxide of titanium.** Chester (Emmons).

It has some resemblance to schorl, but is infusible; occurs in smallish, long, imperfect, nearly black prisms in granite; rare.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 58.

1824. **Red oxide of titanium.** Middlefield (Emmons).

Flat plates in quartz.

Ibid., p. 59.

1824. **Ferruginous oxide of titanium.** Chester.

"I have discovered one large specimen of ferruginous oxide of titanium in granite, or, I ought to say, a mass of granite, containing 20 or 30 imperfect crystals."

E. Emmons: Loc. Min.; Am. Jour. Sci., 1st series, Vol. VII, p. 255.

1825. **Red oxide of titanium.** Norwich (now Huntington).

Near beryl locality in north of town. In large quartz veins in mica-slate.

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 608.

1825. **Red oxide of titanium.**

Cummington, in mica-schist. Plainfield, well crystallized.

J. Porter: Loc. Min.; *ibid.*, Vol. IX, p. 55.

1825. **Red oxide of titanium.** Cummington, Conway, Goshen.

Stone walls; quartz in mica-slate (C. U. Shepard). Leyden, Worthington (Cleaveland), Middlefield, Shelburne.

1825. **Ferruginous oxide of titanium.**

Chester, with augite and actinolite; likewise in sienite. Goshen, in stone wall in mica-schist (Shepard) and quartz.

Robinson's Cat., pp. 42, 51.

1827. **Red oxide of titanium.** Williamsburg.

In quartz in mica-slate; crystals as large as a man's thumb and handsomely geniculated.

Goshen and Chesterfield; Conway and Whately; wherever there are granite veins, or where quartz lies contiguous to mica-slate, and in nests of quartz in mica-slate.

A. Nash: Lead mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 259.

1831. **Red oxide of titanium.** Cummington.

Fine crystal near soapstone quarry.

J. Porter: Loc. Min.; *ibid.*, Vol. XX, p. 170.

1835. **Red oxide of titanium.**

Leyden, with zoisite. Shelburne, Colerain, Conway, Williamsburg, Chesterfield, Middlefield, Whately, in sienite. Windsor, in chlorite slate near the most eastern soapstone quarry, in feldspar, or rather in graphic granite, which occupies seams in chlorite slate.

E. Hitchcock: Geol. Mass., pp. 349, 462.

(The Whately mineral is allanite.)

1838. **Titanium.** Norwich.

Farm of Mr. Quartus Angell, in vein 3 feet wide, with galena and blende.

E. Hitchcock: Econ. Geol., p. 127.

1841. Red oxide of titanium or rutile.

In mica slate; four to eight sided prisms, generally striated, sometimes geniculated. With zoisite in Leyden, abundant, sometimes penetrating quartz, sometimes is connected with hornblende. Shelburne, in distinct crystals alone. Colerain, Conway; in latter place one or two geniculated prisms more than an inch thick, also in small, right square prisms; Williamsburg, Chesterfield, Middlefield.

E. Hitchcock: Geol. Mass., p. 607.

1844. Rutile. (*Rutilus quadratus*.) Shelburne, Leyden. Conway.

J. D. Dana: Sys. Min., p. 420.

1876. Rutilite. Pelham, Conway, Shelburne, Chester.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 7.

1883. Rutile. Westhampton, Chester.

In geniculate crystals an inch long; north part of Westhampton, at residence of Mr. James Howard. In epidotic hornblende schist in Chester.

E. E. Bancroft, class of 1883, Amherst College.

1884. Rutile. Pelham asbestos mine.

Occurs in beautiful, geniculate twins in cavities in tourmaline with apatite prisms and in disseminated red-brown grains and microscopic crystals in massive anorthite, $1\frac{1}{2}$ cm. from contact with massive tourmaline.

1885. Rutile. Rowe.

In pyrite at J. M. Davis & Co.'s mine; steel-gray; good crystals.

A. G. Dana: Gahnite of Rowe; Am. Jour. Sci., 3d series, Vol. XXIX, p. 456.

1885. Rutile. Chester emery mine.

The rutile follows corundophyllite, generally in fine needles, hair brown, shining, striated; at times bent and twisted; generally grouped into sagenite-like bundles of striated needles; rarely twinned, but at times showing a most beautiful lace-work of needles crossing at 60° and 120° , which is set free by the solution of the calcite; at times shorter crystals occur, 10 by 15 mm. across.

There are fine brown-red sagenite needles in a reticulate network at 60° and 120° , together with striated geniculate twins 10 by 15 mm. across, in the cabinet of the late Mr. Ames, of Chicopee.

SALT.

1880. Chiastolite. Near Springfield, Mass.

My attention was called to these forms as problematical, possibly chiastolites, from near Springfield, by Professor Dana, with reference to Mr. B. Horsford, of Springfield, and Mr. J. S. Diller.

1888. Salt. West Springfield. (See Pl. I, B, C.)

In black Triassic shale in bottom of Westfield River, near bridge below the town. Skeleton cubes pseudomorph in calcite, appearing on surface of the black shale in white crosses, squares, and triangles one-half to three-fourths of an inch across, which have been for years called chiastolite. They were determined by me from a study of thin sections, and were found to effervesce with acid.

Specimens received from Mr. J. S. Diller, and sections cut.

1889. Cavities from salt crystals in Triassic sandstone. Wilbraham.

Flattened, cubical hollows, with ends 1 by 4 mm. to 4 by 9 mm., in rusty sandstone from the base of the Trias, east of the academy and near contact on mica-schist.

1890. **Salt.** Holyoke.

In drift near west end of Connecticut River Railroad Bridge. Found by Rev. J. Provost, of Springfield, Mass. Specimen now in the Smith College collections. (See A, Pl. I, from photograph.)

Forms larger and more delicate than at Westfield; largest cube 32 mm. The slender white lines, often with a black central suture, start from a point or from the corners of a small white square with black center. They are often symmetrically bordered by a feathery fringe of white, broadest at base and lessening outwardly, like frost flowers or the micro-lites in Arran pitchstone. That they are cross sections of skeleton cubes is made clear by sections of the same crystal at right angles to each other on the side and end of the block. The rock is a black shale, and the joint plane at one end is incrustated by coarse calcite with streaks of bitumen and rust.

1890. **Salt.** Holyoke.

The impressions of minute salt crystals also occur on the very thin, laminated, and fine-grained sandstone cut through in carrying the water main east from Ashleys Pond, in Holyoke, in lines crossing each other at 90° ; lines diverging at 60° , and small impressed squares with lines diverging from the four corners.

1892. **Spinel.** Near Springfield, Mass.

Octahedral crystals tessellated like chiasolite embedded in slate.

E. S. Dana: Sys. Min., p. 222.

1894. **Octahedrite.** West Springfield.

I have in time past had much correspondence with Mr. Horsford concerning these forms. He considered them a new mineral, an eightfold dissectible crystal, each component having the shape of the octant of an octahedron, and he proposed the name octahedrite for the form. He expressed the intention to publish his results as part of a larger work on geology, of which the manuscript was prepared and partly printed, but never published.

The following quaint letter explains more fully than I have done Mr. Horsford's opinion concerning his mineral, and will be of interest to many who remember his peculiar, Indian-like appearance and his crisp, impulsive speech.

The first lines and the allusion to Professor Shepard are interesting reminiscences of early studies of chiasolite, and refer to the dissected figure, which has for many years appeared in the different editions of Dana, and which has given rise to German citations of chiasolite from Springfield, Mass. As the author died two years ago, and his representatives do not object, and as his promised book will probably not be printed, I reproduce the letter, following religiously the injunction of the author. The letter was accompanied by a small octahedron carefully cut in pine wood, and with blackened corners to show the three black plates mentioned below:

"NORTH THETFORD, VT. (No date. Received about 1890.)

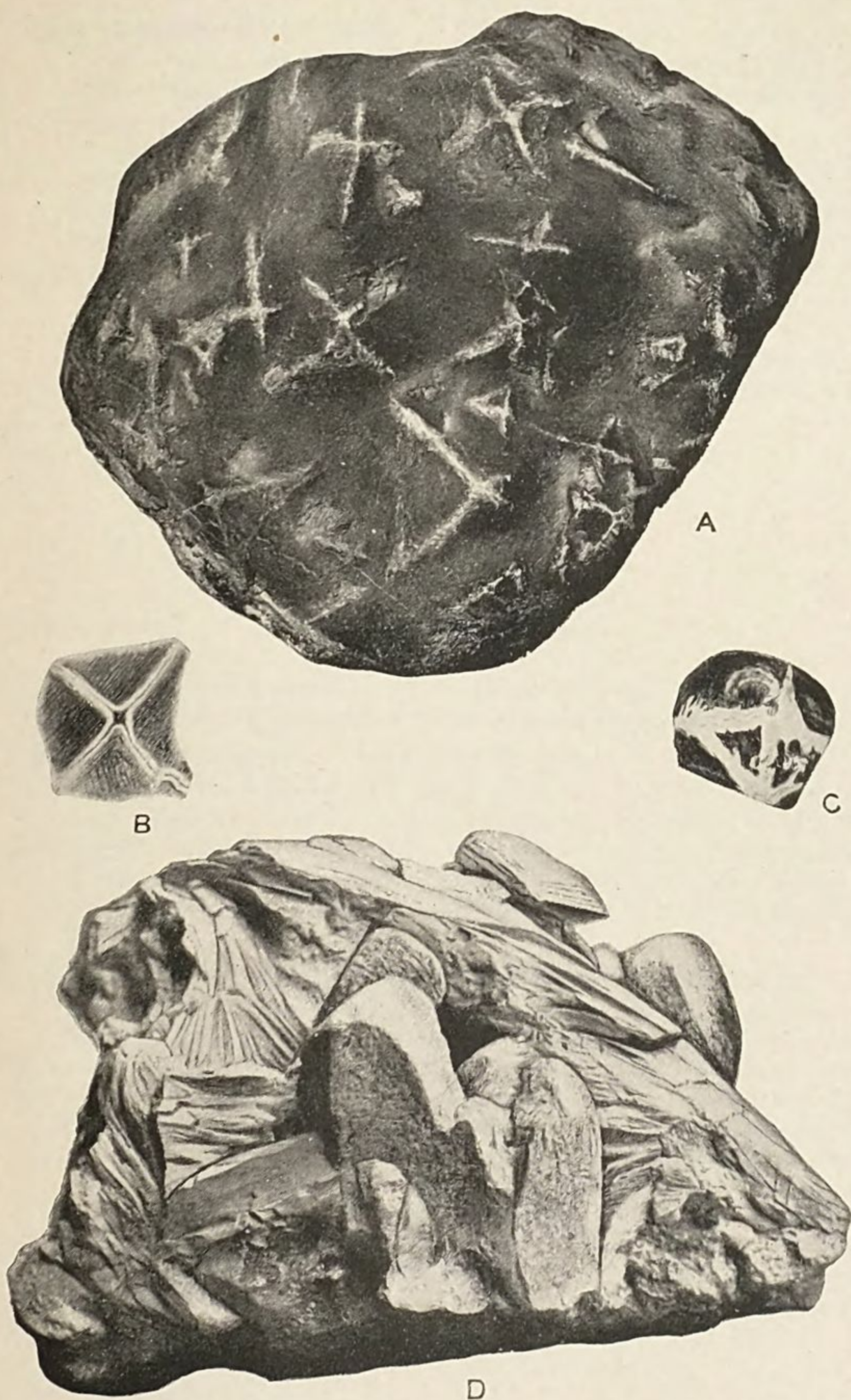
"DEAR SIR: The chiasolite, a right square or rhombic prism, is composed, as you see, of five right square pyramids (black) and four triangular pyramids (white) fearfully elongated, all of massive structure and inseparable. My octahedrite, a regular octahedron, white, is bisected through its angles by three black plates, which diagonally, at right angles, bisect each other. These plates are walls of division; consequently the octahedron is composed of eight triangular pyramids, separable and of distinct laminated structure. You may wonder that a New Englander, a Yankee

1894. **Octahedrite**—Continued.

Puritan thoroughbred, should carry a discovery like this twenty years in his pocket with no effort at heraldry or one attempt to turn it into cash. But you will acquit me of weakness in that direction when I say I had possession of all the specimens discovered and all that would be discovered until there was another upheaval—a contingency I could well risk. I am not able in a letter to say what I would, not knowing just what you desire. My researches for twenty years past are all embodied in a work in publication, and of which I send you the first chapter with the assurance I mean all I say and can sustain it. I could doubtless contribute somewhat to your report, but that could only be by extracts from my own book. I would show you where the mica schist overlies the sandstone and where basalt does the same; where, in an opening in the sandstone, there was an irruption of fetid limestone with stalactites in all the curly crinkles of malachite, but of shades from brown to black. The elder Hitchcock, in his first report on the geology of Massachusetts, described them as radiaria (petrified worms). His engrossing study of bird tracks at that time made the oversight pardonable. You will see at once the position in which I am placed. In my treatise the geology of New England is treated with a philosophic scrutiny it has not before seen, however much needed, holding as it does a more direct and unimpeachable testimony of the earth's early history than any field of equal extent on the globe.

"I acknowledge I am *savage* in treatment of the glacial theory, but assuming less I had better kept silent. But if fact and philosophy both sustain my position, as they certainly do in overwhelming multiplication, I could not say less or too much. I can show you three 100-ton bowlders of granite which have burst asunder in the past five years, one I had known half a century without seam or fracture in it. All burst in one direction, and at the same angle from perpendicular, and through the middle. Would not geologists attribute that work to Achaean time rather than the present? I have never found a specimen 100 feet from one spot (point). I have not been able to obtain a single specimen in the past five years. I have a few crystals developed showing just what the model does. I have a few halves, quarters, and eighths of the octahedron, but consider them invaluable, as they can not be duplicated. I have never sold or given a specimen to any person living. I did not discover for years that the pyramids were separable. You may think I hold this thing with grip of iron, but it is not so. Approaching my eightieth birthday, it is a fair hope that I have gathered a little wisdom or moiety of caution by the way. When I dissected the andalusite, at the solicitation of your late Professor Shepard, I sent description and illustration to the Natural History Society of Boston, but never received a word of reply.

"Two years ago, I think (this is allegory), a doctor came up to Springfield from Harvard to consider the case of a *sickly infant*, administering a dose of '*rehash of old hash*' on the sandstone. Well, either from the prescription or the method of administration, the poor thing gave a gasp or two and 'passed away.' At the close of the lecture, however, we gathered about the speaker for a friendly chat. When the question of the crystals came up, it was thrown back in my face with 'It is beyond my comprehension; I do not wish to know or hear anything in regard to it,' with other exclamations I did not wait to hear (Shaler). These things have been often repeated in my long life of research, so that what I might contribute to the geology of New England, if given at all, must be with the assurance from the Secretary of the Interior that it shall be published in my own words and under my own signature exclusively.



CRYSTALS OF SALT AND HAMPSHIRITE.

- A. Pseudomorph in calcite of skeleton crystals of salt.
B. Central section of above salt pseudomorph.
C. Section of corner of same crystals, showing feathery outgrowth.
D. Hampshireite; pseudomorph of serpentine after olivine.

1894. **Octahedrite**—Continued.

"The crystals are embedded in black shale just like cherries in a pudding. I have them in hundreds, which I should be happy to show you on my return to Springfield.

"Do not mistake me, I am willing to give all the assistance in my power; but as I am publishing it all in a work of my own, I must not impair or imperil that. The survey on which you are engaged must take years of time. I should like to know more about it, as I am, and shall be while I live, actively engaged in geological research.

"I shall be here probably till September.

"Yours, truly,

"B. HORSFORD,
"North Thetford, Vt."

The following appears as a separate marginal note:



FIG. 4.—Section of salt pseudomorph.

"One side of the octahedron, the first discovered. The crossing lines of the triangle are mathematical (please demonstrate)."

1894. **Salt pseudomorphs.** West Springfield.

Through the kindness of a daughter of Mr. Horsford the finest specimens from his collection have been presented to the collection of Amherst College. They are smaller than those from Holyoke. One slab 7 inches square and finely ice-polished shows the forms in great beauty, and especially six-rayed stars from sections normal to the octahedral axes of the cube.

1894. **Calcite pseudomorphs after salt in Triassic shale.**

"A specimen of the fine black shale of Triassic age is covered with white lines arranged in triangles, crosses, and lines radiating from the corners of small squares. A feathery outgrowth at times borders these lines. The material is calcite, and the lines are tracings of the various chance cross-sections of skeleton cubes, about an inch in diameter, presumably of salt, replaced by calcite. The extreme delicacy of the forms, the feathery outgrowths, and the lack of broken specimens indicate that they were formed in place in the soft mud. They were, I think, discovered by Mr. B. Horsford, of Springfield, and were much studied by him. They have been called chiastolite, and are cited as spinel in Dana's Manual, 1892. The specimen shown was a boulder from Holyoke. Mr. Horsford's specimens were from West Springfield."

B. K. Emerson: Bull. Geol. Soc. Am., Vol. VI, p. 473.

SAPONITE.1882. **Saponite.** Deerfield.

Product of decomposition of natrolite. In many cases the natrolite has changed peculiarly into saponite. At first the tips of the needles become opaque and crumbling, and this extends to the whole group, and the whole sinks down into small masses from milk-white to straw color, which are spread over the surface of the prehnite like a thick layer of

1882. Saponite—Continued.

dried cream, with abundant shrinkage cracks. The hardness is 1 or less. It gives up only a little iron with hydrochloric acid, and is quickly decomposed by hot sulphuric acid. A portion introduced into a drop of water falls asunder much like starch—which it every way resembles—with a series of slight explosions, which occur at first in rapid succession and continue, growing fainter and farther apart, for some little time until the whole is spread in a broad circle upon the glass. This process exposes minute glassy fragments of prehnite. The flakes after their dispersion present a peculiar appearance under the microscope. The first impression is strikingly that of a slide of nearly dried blood corpuscles of uniform size, 0.005 to 0.007 mm., the single disks being variously attached to each other. Separate groups of disks often simulate closely in shape the grub of the common May beetle. The scales polarize brightly in bluish tints and are indistinguishable from kaolin. In many cases a small mass of the mineral seems to have undergone this vermiculite-like reaction in the vein itself, and a delicate bloom is spread in a circle over the prehnite or epidote surrounding a minute hollow cup of the same white or straw-colored material. In one curious case a minute hollow cube, with a side broken in, has a tuft of natrolite needles perched in and around it, these latter having minute dodecahedra of fluor strung upon them, as described below. The whole is now transformed into or coated with the saponite, and a delicate bloom of the same coats the surrounding epidote.

B. K. Emerson: Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 356.

SAPPARE.

See Cyanite.

SAPPHIRE.**1876. Corundumite.**

Pelham: Blue (sapphire) and gray.

Chester: Blue (sapphire) and brown; the latter mixed with magnetite (emery).

C. U. Shepard: Cat. of Min. within 75 miles of Amherst, p. 6.

See Corundum.

SCHEELITE.**1864. Tungsten. Chesterfield.**

In albite near cassiterite.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XXXVII, p. 407.

1867. Scheelite. Chesterfield.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst, p. 2.

1868. Scheelite. Chesterfield.

The above cited.

J. D. Dana: Sys. Min., p. 606.

(The specimen upon which the above determination was made was probably burned with the Shepard collection. Professor Julien does not mention the species in his exhaustive study of the Chesterfield locality.)

SCOLECITE.**1882. Scolecite. Ward's quarry, Pelham.**

In Pelham gneiss in fissure with and on prehnite.

In radiated needles 60 mm. in length, single needles 3 mm. in width; in twins $P, \infty P, \infty P \infty$. Swells abundantly under the blowpipe; extinction 14° from the long axis.

1887. Scolecite. Granby.

In the eighth volcanic core east of the Notch road in Granby. Veins of bluish agate contain very sharp casts of square prisms 2 by $\frac{1}{8}$ mm. in cross-section with flattened transversely striated ends exactly resembling scolecite.

SCAPOLITE.

See Enstatite, 1835; Zoisite, 1824.

SEPIOLITE.**1876. Sepiolite;** varieties, meerschaum and hampshirin. Middlefield.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 3.

The termination "ine" was proposed in this pamphlet as a sort of limbo in which poor species might be reserved for adjudication, and "in" for varieties. This suggestion has been nowhere adopted. For hampshirite, see page 91. It is a compact serpentine and has no similarity to sepiolite. The specimens labeled "meerschaum" in the Shepard collection were weathered portions of the Middlefield serpentine bed, which had lost their color and become light and porous from the leaching out of a portion of the mass.

The presence of true sepiolite has not been established.

SERPENTINE.**1818. Serpentine.** Leyden.

Rolled masses.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. 1, p. 114.

1818. Serpentine rock. Southampton, Russell.

At 723 feet from the entrance of the Southampton adit is a stratum of serpentine rock containing very red quartz embedded in various directions. It is very compact and mostly green; here it is but 3 feet thick. It is compared with the Westfield bed; at 670 feet there is beautiful green soapstone.

Also, near line of Westfield and Russell, 4 miles west of Westfield Academy. Very great breadth; in the granitic hill east of highest ridge of granite.

A. Eaton: Southampton adit; Am. Jour. Sci., 1st series, Vol. I, p. 137.

1820. Serpentine. Middlefield.

Discovered by E. Emmons. Description given; associated minerals, quartz, steatite, actinolite, talc, dolomite.

C. Dewey: Ibid., Vol. II, p. 236.

1820. Serpentine. Westfield.

Four miles west of academy. "I discovered a very extensive bed of serpentine."

A. Eaton: Index, p. 100.

1821. Serpentine. Russell.

Specimens sent to Professor Silliman by Dr. William Atwater, and described by the former. Also from a mountain 15 or 20 miles from Westfield, a bluff large as East Rock (probably Middlefield).

Am. Jour. Sci., 1st series, Vol. III, p. 238.

1823. Serpentine.

Westfield, in granite (Eaton). Middlefield, associated with steatite (Dewey). Pelham, in a large, loose mass, penetrated by asbestos and associated with talc.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 227.

1824. Asbestos (Amianthus).

In very strong and flexible fibers in steatite. Middlefield (Emmons). Ligniform, white and yellowish-white fibers, stiff and brittle, traversing serpentine in vein at Middlefield (Emmons).

Compact in Middlefield with serpentine.

C. Dewey: Geol. Berkshire; *Am. Jour. Sci.*, Vol. VIII, p. 47.

1824. Serpentine. Middlefield, Worthington, Plainfield.

Bed 2 miles long, 2 miles south of the meetinghouse in Middlefield; light and dark green. In neighboring brook white and cream colored; spotted, translucent, beautiful. Both precious and common. In Russell, a little east of south of above, large beds dark-green; has been polished for marble. In Middlefield, east of meetinghouse, connected with great bed of steatite; also Worthington and Plainfield.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 49.

1824. "Vert antique?"

A magnesian mineral found in a bed in gneiss on the river in Becket and colored greenish by serpentine. It may, as Dr. Emmons thinks, be a serpentine marble; tough, takes fine polish; effervesces, often yellowish-white.

C. Dewey: Geol. Berkshire County; *ibid.*, p. 58.

(This is the Coles Brook pre-Cambrian chondrodite limestone, which is often partly altered to serpentine.)

1825. Serpentine. At the foot of the mountain west of Westfield.

Emerson Davis: *Min. Not.*; *ibid.*, Vol. IX, p. 252.

1825. Pimelite. Middlefield.

At locality of crystallized steatite. (See Pimelite, p. 122.)

C. U. Shepard: *Bost. Jour. Phil. and Arts*, Vol. III, p. 609.

1825. Serpentine. Zoar, Worthington, Deerfield River.

Robinson's Cat., p. 78.

1826. Serpentine.

On the mountain 5 miles west of Westfield Academy are two beds of serpentine, one not before mentioned; in mica-slate with limestone at south end of bed and in terstratified with serpentine at right angles, or 90°.

Serpentine intercalates and alternates with an unknown mineral resembling lime 1 inch in thickness; sometimes they are blended. Vein contains schorl and actinolite. A cross section of the bed is as follows: Green talc, serpentine, unknown mineral, serpentine, green talc. On the opposite side of the river, 1 mile north of this, another bed—mentioned by Eaton in Index (*Am. Jour. Sci.*, 1st series, Vol. VI, p. 227, Hitchcock). In mica slate, not in granite. Black, greenish on thin edges, foliated, laminae with luster of hornblende; sp. gr. 2.6; powder attracted by magnet; proposes variety name "magnetic serpentine." A yellow-green, foliated mineral occurs in the serpentine—probably sahlite. On the Westfield River bank between these localities are boulders of tons weight of talc with fragments of black serpentine containing 4-sided prisms, hair-brown—anthophyllite?

Emerson Davis: *Rocks and minerals of Westfield*; *Am. Jour. Sci.*, 1st series, Vol. X, p. 213.

1826. **Serpentine**—Continued.

The first of these localities is Munns Brook, and the unknown mineral is enstatite. The second locality is Atwater's quarry and the mineral bastite (marmolite). The third mineral is enstatite.

1832. **Serpentine.**

Middlefield, south part; one-fourth mile in breadth, 2 miles long in north part, with steatite; precious and common. Blandford, three beds. Westfield, west part, going into Russell, dark, with green talc; has been worked. Pelham, southwest part; dark, much talc. Zoar, southeast side Deerfield River, near turnpike.

E. Hitchcock: Geol. Mass.; *ibid.*, Vol. XXII, p. 30.

1833. **Serpentine.** Zoar, Blandford, Middlefield.

E. Hitchcock: Geol. Mass., p. 30.

1835. **Serpentine.** Zoar, Blandford, Middlefield (two localities).

Blandford, 4 miles northwest of the church on the northeast side of North Meadow Pond; discovered about 1834 by Mr. Simeon Shurtleff (Geol. Mass., p. 305); 30 rods in diameter; stratified; on west, hornblende schist; also 4 or 5 miles south, 40 rods east of soapstone quarry (Osburn's); also boulders of peculiar green serpentine with talc and schiller spar on east line of town. Westfield, in mica-slate, 4 rods wide, black with talc, scapolite (?), massive garnet, amphibole, and calcite. Russell, apparently in continuation of above, on north bank of Westfield River, black and green with deweylite. Pelham, with talc and asbestos in gneiss. Shutesbury, black, mostly steatite. New Salem, steatite passes into black serpentine in gneiss.

E. Hitchcock: Geol. Mass., pp. 30, 367 ff.

1841. **Serpentine.**

Nearly all above localities cited, especially page 614—a compact topographical résumé. Middlefield and Becket, in cuttings on railroad; a delicate variety mixed with the limestone.

E. Hitchcock: Geol. Mass., Final Report, pp. 159, 567, 610, 614.

1841. **Amianthus.** Russell, in serpentine.

E. Hitchcock: Geol. Mass., p. 618.

1844. **Serpentine.** Westfield, Russell, Blandford, Chester, Middlefield, Charlemont, Zoar.

E. Hitchcock: Ex. Geol. Map, p. 12.

1844. **Serpentine** (*Ophitis communis*). Blandford, Middlefield, Westfield.

J. D. Dana: Sys. Min., p. 309.

1876. **Serpentine.** Chester and Middlefield.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 3.

1876. **Picroline.** Middlefield; Chester.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 3.

1882. **Serpentine.** Russell.

Black serpentine with bastite. Analysis by Prof. C. U. Shepard. Sp. gr. 2.60; H. 5.

SiO ₂	44.16
MgO	37.44
FeO	7.05
H ₂ O	11.00
	99.65

1892. Picrolite. Chester.

Beautiful deep leek-green; fibrous, the fibers not easily separating; on alteration becoming colorless, and developing a pearly luster and a micaceous or talcky cleavage, and at the surface changed into a fine tough-fibered serpentine—asbestos. Exposed in a bed several feet across in the railroad cutting at the first bridge north of the Chester station. This is widely separated from the large Chester-Middlefield band.

1893. Serpentine.

The series of great serpentine beds which extends across the State from Rowe to Granville is of more lithological than mineralogical interest, and is treated at length in the monograph on the geology of the area. A detailed microscopical study failed to detect any trace of olivine or of olivine structure in any of the beds except the eastern Osborn bed.

The eastern line of beds, from Munns Brook in Granville to Osborn's quarry in Blandford, is derived from coarse enstatite rock. The lower bed at Osborn's quarry is from a coarse pyroxene rock. The long line of beds from Blandford north to Rowe are derived from hornblende-schist, and where the road from Chester to Middlefield crosses the bed one sees the most perfect pseudomorph of serpentine after hornblende-schist imaginable, every detail of structure of the hornblende schist south of the river being repeated on the surface of the vertical walls of serpentine, while on breaking into the mass only the black massive serpentine appears, without a trace of schistose structure. After a long and careful search had failed to find any trace of olivine in these serpentines, I was surprised to find in the so-called serpentine pseudomorphs after quartz from the Middlefield bed pseudomorphs after olivine of large size and great beauty. I have therefore given the history of these forms separately under the name hampshirite (q. v.), although the material is not proved to be a distinct species.

East of the river all the serpentines in Pelham and Shutesbury are derived from olivine.

1894. Serpentine pseudomorphs after olivine (formerly called quartz pseudomorphs). Middlefield.

A specimen, presumably unique, was shown, having several large attached crystals more than an inch long, showing the common forms of olivine now changed into a pale yellow serpentine, closely resembling the Snarum forms. The crystals have long been cited as quartz pseudomorphs from Middlefield, but the locality has been lost for many years. This specimen is from the collection of Mr. James Clark, formerly of Brooklyn, and now belongs to Smith College. Its label states that the locality was on the brook which crosses the great serpentine bed in Middlefield, and that it was purposely covered up by someone many years ago.

B. K. Emerson: Bull. Am. Geol. Soc., Vol. VI, p. 473.

1895. **Serpentine.***Analyses of serpentines.*

[Nos. 1-5 by Mr. George Steiger, in the laboratory of the Survey; No. 6 by Miss H. P. Cook, instructor in chemistry in Smith College.]

	1.	2.	3.	4.	5.	6.
SiO ₂	37.82	40.42	36.94	39.14	33.87	40.27
TiO ₂	Trace.	None.	Trace.	None.	None.	.....
Al ₂ O ₃	.61	1.86	.50	1.18	.77	} 5.74
Fe ₂ O ₃	7.92	2.75	6.04	4.46	2.81	
FeO	1.15	4.27	1.94	3.14	4.25	.....
FeS ₂ .....	.....	.43	.....	.....	.....	.....
Cr ₂ O ₃	.19	.28	.33	.33	.38	.....
NiO	.45	.53	.40	.47	} .33	.....
CoO	.05	Trace.	None.	Trace.		.....
MnO .....	.....	Trace.	Trace.	None.	.04	.....
CaO	None.	.66	None.	None.	None.	.....
BaO	None.	None.	None.	None.	None.	.....
MgO	37.94	35.95	38.33	41.45	38.57	40.00
K ₂ O	} Trace.	Trace.	None.	None.	None.	.....
Na ₂ O .....		.....	.....	.....	.....	.....
H ₂ O — 100	.75	.21	.71	.34	.38	.69
H ₂ O + 100	12.50	10.51	12.07	9.48	7.00	13.61
SO ₃ .....	.....	Trace.	.20	None.	.20	.....
P ₂ O ₅	Trace.	Trace.	Trace.	.02	Trace.	.....
CO ₂ .....	.....	1.44	1.85	None.	10.82	.....
	99.38	99.31	99.31	100.01	99.42	100.31

No. 1. Enstatite changed to serpentine. Granville. H. Cooley's.

No. 2. Rich dark-green serpentine. Rowe. Quarry near R. King.

No. 3. Black serpentine containing marmolite (bastite). Russell. Atwater's quarry.

No. 4. Black-green serpentine, weathering to pale nickel-green with much chromite. North Blandford, from "The Crater."

No. 5. Gray splintery serpentine enveloped in talc. Chester. From the east wall of the old mine.

No. 6. Straw-yellow fibrous serpentine, glazed, enveloping olivine pseudomorphs. Middlefield. From the specimen figured; Plate I.

SILLIMANITE.

1876. **Fibrolite.** Northfield, Sillimanin, Chester.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 6.

(The Northfield specimens are in boulders from New Hampshire.)

1878. **Sillimanite.** Palmer.

Prisms not well formed, but standing out from their marked cleavage.

Groth: Min. Sammlung, Strasburg.

The specimen was doubtless from a boulder from the range of fibrolite rock in the granite in Belchertown.

1881. **Fibrolite.** Amherst.

In the feldspathic mica-schist along the west of the ridge on which the village is built from the college grove to the Agricultural College; the rock is spangled in cleavage faces with large (one-half inch) equidistant blotches of shining white muscovite, shot through with blades of fibrolite. This changes with the rest of the rock into an amber-colored, soft agalmatolite (?).

1883. **Sillimanite.** Belchertown, Enfield.

In the east portion of Belchertown, at house of Mr. J. Clough, commences a great mass of sillimanite gneiss, forming an inclusion in the tonalite. Crystals, square prisms up to 1 inch long.

1885. **Sillimanite.** East Brimfield. Near house of William Lombard.

The coarsest specimens found in fissures in calcareous pyroxenite, 45 mm. long, 5 mm. wide.

1891. **Fibrolite.** Warwick, south of Harris's soapstone quarry.

In pure white straight fibrous masses of great beauty and large size, resembling pycnite. It occurs in coarse granite on the border of fibrolite schist, and seems, as is often the case, to have been dissolved out of the country rock and concentrated by recrystallization in the pegmatite in purer form. It is the characteristic mineral of the Brimfield schist, which occupies the eastern portion of our area and extends over a large part of Worcester County.

SIDERITE.

1835. **Lenticular carbonate of iron.** South Island, Turners Falls.

For several rods around copper vein, numerous crystals.

E. Hitchcock: Geol. Mass., p. 226.

1858. **Chalybite.** Turners Falls, South Hadley Falls.

E. Hitchcock: Catalogue of State collection; Nos. 111, 112, 6th Report State Board of Agri., p. xx.

(The piece from Turners Falls shows a surface of Triassic sandstone, incrustated with fine, large rhombohedra— $\frac{1}{2}$ R, now changed to limonite. In the specimen from South Hadley Falls fissures in red Triassic sandstone are incrustated with shining red crystals, shot through by long needles of a white mineral, which has now almost wholly disappeared. The specimens are in the survey collection of Massachusetts, made by President Hitchcock, and deposited in the Amherst College Museum.)

1859. **Spathic iron.** Goshen.

With zoisite and specular iron in mica-slate.

E. Hitchcock: Final Cat. State Col. No. 17, Mass. Agr. Rep., App., p. xl.

See Ankerite.

SILVER.

1810. **Silver.**

Loudville, 12 $\frac{1}{2}$ ounces to the ton.

B. Silliman: Bruce's Jour., Vol. I, p. 69.

1841. **Silver.** Southampton.

A chapter on "Misguided efforts in search of gold and silver."

E. Hitchcock: Geol. Mass., p. 206.

SPHALERITE.

1810. **Blende.** Loudville, Southampton.

Crystals on quartz.

B. Silliman: Bruce's Jour., Vol. I, p. 68.

1823. **Sulphuret of zinc.**

Loudville, foliated and crystallized. Leverett, foliated.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 235.

1827. **Blende.** Hatfield and Leverett.

A. Nash: Lead mines of Hampshire County; *ibid.*, Vol. XII, p. 258.

1835. **Blende.** West Springfield.

In fetid limestone in Paine's quarry and Meacham's quarry; rare. (Triassic.)

E. Hitchcock: Geol. Mass., p. 230.

1838. **Blende.** Russell, Norwich.

Russell, farm of John Gould. Norwich, farm of Quartus Angell. (In quartz veins in Conway schist.)

E. Hitchcock: Econ. Geol., p. 127.

1841. **Blende.** Northampton, Norwich (now Huntington).

The principal ore in vein in Northampton 1 mile northeast of the Loudville vein. (Both baryta-lead veins in granite.) In Norwich 1 mile northeast of the meetinghouse; opened by Quartus Angell; elegant quartz.

E. Hitchcock: Geol. Mass., p. 204.

1844. **Zinc.** Northampton, Norwich.

E. Hitchcock: Explanation of Geol. Map, p. 22.

1859. **Blende in quartz.** Norwich, Holyoke.

Large mass in State collection in Amherst College; from Angell's mine. Cat. No. 200, p. xix.

Fine, transparent cleavage pieces in fissures in clayey limestone. (Trias.) Holyoke. Cat. No. 107, p. xlix. Ibid.

Rep. Agri. of Mass. for 1858, App. lxix.

1882. **Sphalerite.**

Rarely in red-brown grains 5 to 6 mm. long, fresh looking and of high luster in the interior, but generally surrounded by a bright-red rust layer. In prehnite, epidote, and calcite, and in the light-gray diabase, filling cavities lined with diabantite, with curious many-faceted globules.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 350.

1883. **Sphalerite.** Leverett. East mine.

In fine transparent olive-green, complexly twinned crystals nearly an inch across. Found by Mr. E. J. Whitaker, of the class of 1883, Amherst College, and deposited in the college cabinet. From baryta-lead veins in granite.

1891. **Sphalerite.** Hatfield.

Occurs rarely in fine druses of black crystals, in part transparent, and then oil-green; complex twins, mainly ∞ O and O. The blende and the barite together coat the walls of the veins, and quartz follows. From baryta-lead veins in tonalite.

1894. **Sphalerite.** Sunderland.

Large transparent wine-yellow pieces in fetid concretionary limestone at the fossil fish locality in black Triassic sandstone at Whitmore's Ferry.

SPINEL.

1892. **Spinel.** "Near Springfield, Mass."

"Octahedral crystals tessellated like chiastolite," embedded in slate.

E. S. Dana: Sys. Min., p. 222.

These are skeleton crystals of salt, now pseudomorph by replacement in calcite, and occur in the black Triassic shale at West Springfield. (See Salt.)

SPODUMENE.

1823. **Augite.**

Goshen, in granite. Flattened, greenish-gray prisms, sometimes 8 inches long and 2 inches wide, 1 mile north of meetinghouse on Ashfield road.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 225.

1824. Spodumene. Vicinity of Conway.

Partially analyzed, light-green color.

George T. Bowen: Jour. Acad. Nat. Sci., Philadelphia; also Am. Jour. Sci., 1st series, Vol. VIII, p. 120.

1824. White augite. Goshen.

At the celebrated locality of indicolite.

J. Porter: Loc. Min., p. 233.

1824. Spodumene? Chester.

In small quantity in granite.

"By the action of the blowpipe it is first converted into scales or plates, which then melt into a glass; brittle, scratches glass, yellowish or pale green."

C. Dewey: Geol. Berkshire County; Supp. Am. Jour. Sci., 1st series, Vol. VIII, p. 243.

1825. Spodumene. Goshen.

"The mineral already described (Am. Jour. Sci., 1st series, Vol. VI, p. 225, Vol. VII, p. 30) as white augite turns out to be spodumene. It exists in various parts of Goshen, especially the northern part. Not as yet noticed in place, but the granite boulders are so massed that they certainly are the upper portion of a great bed beneath."

E. Hitchcock: Loc. Min.; *ibid.*, Vol. IX, p. 20.

1825. Spodumene. Goshen.

"The white augite mentioned in American Journal of Science (1st series, Vol. VIII, p. 233) is I believe, spodumene. Correction."

J. Porter: Min. Not.; *ibid.*, p. 55.

1825. Spodumene. Goshen.

"At the celebrated tourmaline locality and several other places."

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 607.

1828. Spodumene. Norwich (Huntington).

"Was conducted to hill near the north line of Norwich, where I found spodumene in large laminated masses."

E. Hitchcock: Am. Jour. Sci., Vol. XIV, p. 220.

1831. Spodumene. Chesterfield.

In coarse granite with beryl near celebrated tourmaline locality. Crystals large, often apple-green.

J. Porter: Loc. Min.; Am. Jour. Sci., 1st series, Vol. XX, p. 170.

1841. Spodumene.

Goshen, most abundant; 2 miles north of village on the Ashfield road; 3 miles northeast on the Plainfield road. Chesterfield, Norwich, Chester; prisms from Chesterfield 21 inches long, though broken at both ends (Dr. Dwight, Cummington); white or gray; small specimens delicate green or light rose.

E. Hitchcock: Geol. Mass., p. 701.

1844. Spodumene. (*Petalus triphanus*.) Goshen, Chesterfield, Chester.

J. D. Dana: Sys. Min., p. 360.

1850. Spodumene. Norwich.

	<i>Analysis.</i>	
	I.	II.
SiO ₂	63.06	62.72
Al ₂ O ₃	28.00	28.85
CaO	.95	1.13
LiO	5.67	5.67
NaO	2.51	2.51

100.19 100.88

G. J. Brush: Am. Jour. Sci., 2d series, Vol. X, p. 370.

1850. **Spodumene.** Norwich.

A crystal belonging to Mr. Charles Hartwell was noticed by him at the meeting of the American Association for the Advancement of Science, 1849. On examination Professor Dana finds that the mineral is monoclinic and isomorphic with pyroxene. The crystal is described and figured and measurements are given, and the formula given is $0 P, \infty P, \infty P \infty, \infty P \infty, \infty P' \infty, P, 2 P, 2 P' \infty, 3 P 3 (?)$, $m P n$; another crystal has the faces $0 P, 3 P 3, m P n$ wanting; gives strong lithia reaction. Formula $R_3Si_2O_3 + 4Al_2O_3Si_2O_3$ (Kobell).

NOTE.—The spodumene of Conway in the same range was tested for lithia successfully in 1824 by G. T. Bowen.

J. D. Dana: Ibid., p. 119.

1853. **Spodumene.** Norwich.

Reanalyzed as follows:

	No. 1.	No. 2.	No. 3.
SiO ₂	64.04	63.65	63.90
Al ₂ O ₃	27.84	28.97	28.70
Fe ₂ O ₃	.64		
CaO	.34	.31	.26
Mgo	Trace.	Trace.	Trace.
Li ₂ O	5.20	5.05	4.99
Na ₂ O	.66	.82	.80
K ₂ O	.16		
Ignition	.50	.50	.60
	99.38	99.30	99.25

Smith and Brush: Ibid., Vol. XVI, p. 371.

1865. **Spodumene.** Huntington.

Mr. F. R. Allen of the class of '65, Amherst, found a large boulder of spodumene granite at the west foot of Walnut Hill, with many crystals of a type unusual for the region. Small square prisms very fresh and well terminated. The specimens have been presented to Amherst College.

1866. **Spodumene.** Winchester, N. H.

Just over the line. Continuation of Goshen formation, on land of Mr. Brown, under barn and in brook-bed near bridge; cleavable masses; most northern location of the species.

C. U. Shepard: Ibid., Vol. XLII, p. 248.

(The term "Goshen formation" refers to the albitic tourmaline granites of Goshen.)

1876. **Spodumene.** Goshen.

North of Lily Pond in the north of Goshen is a heavy bluff of biotite granite, and a few rods north is a large bedded dike of muscovite granite. In this I found, in 1876, pseudomorphs of muscovite after spodumene 2 inches broad by 6 inches long, and recognized them then as such.

1876. **Spodumenite.** Goshen, Huntington (formerly Norwich).

C. U. Shepard: Cat. of Min. within 75 miles of Amherst, p. 5.

1878. **Spodumene.** Norwich.

Analysis affording formula: Li_2, Al_2, Si_4, O_{12} .

C. Doelter: Ueber Spodumene und Petalite; Min. Mit., Vol. I, p. 517.

1879. **Spodumene.** Goshen, Chesterfield, Huntington.

Goshen, Manning farm. Imperfect bladed crystals up to 2 inches across in coarse aggregate of albite, indicolite, and garnet.

1879. **Spodumene**—Continued.

Barras farm. Rectangular crystals up to 18 inches long, often changed to cymatolite. The well-known tourmaline locality, Chesterfield.

A. Macomber farm; northwest corner of town, 2 miles southeast of village of East Cummington; first opened by Professor Julien in 1870. Clark ledge, the well-known locality of colored tourmalines, contains no spodumene.

West Chesterfield Hollow. Isinglass rock; crystals up to 35 inches long, 10 to 11 inches across, changed to cymatolite, albitic granite, quartz. Vein worked three summers by Professor Julien. Four miles farther south in Huntington (formerly Norwich), on Walnut Hill; the vein which has furnished the finest crystals up to 16 inches long. Chester, 1 mile north of village; opened by Emmons.

Manning farm. Coarse aggregate of albite, indicolite, garnet, and spodumene; where crowded and imperfect grains indicate a more rapid crystallization than in the other localities.

Barras farm. Main vein orthoclase; granite with beryl; central band or secondary vein of cleavelandite and gray-white quartz with spodumene and tourmaline, beryl green and white, garnet, muscovite, columbite, cassiterite—apparently a later deposition of quartz.

Macomber farm. First vein the same; in secondary, 1st, quartz, muscovite, granular albite, tourmaline, spodumene; 2d, cleavelandite, quartz, magnetite, garnet, zircon; 3d, smoky quartz, green and black tourmaline. The larger crystals penetrate through all the formations.

Clark's. Same, no spodumene; 1st, albitic granite, little quartz and muscovite, black tourmaline and garnet; 2d, cleavelandite, black, green, and brown tourmaline, microclin, columbite, cassiterite, zircon, cookeite, lepidolite; 3d, center, smoky quartz.

Chesterfield Hollow. Granite, no beryl, little mica; 1st, orthoclase, huge crystals, 6 to 10 inches; green and white quartz; 2d, albitic granite, green muscovite, spodumene, green, white, and black, 10 to 25 pounds; quartz, columbite, masses one-half pound in weight, zircon, rich in uranium; 3d, quartz and cleavelandite; 4th, magnetite, quartz, zircon, spodumene, yellowish, white, and black; 5th, smoky quartz, green spodumene, green and black muscovite, 2 to 3 inches; columbite, zircon.

Walnut Hill. First, muscovite, granite; 2d, albitic orthoclase, black tourmaline, muscovite, garnet, magnetic quartz; 3d, cleavelandite, with quartz, spodumene, tourmaline, tripolite, cyrtolite, quartz, apatite, muscovite, green, white, and black; 4th, spodumene, muscovite, granite, biotite, magnetite, cyrtolite.

A. A. Julien: Ann. N. Y. Acad. Sci. Arts, Vol. I, pp. 316, 350.

(The article contains careful analyses and a full discussion of them, establishing independently of Doelter the same formula. The paragenesis of the mineral and its alterations into killinite, cymatolite, vein granite, and quartz, are fully described (see p. 115), making this the most valuable article that has been published upon the granitic veins which carry rare minerals in our western hills.)

1885. **Spodumene**. Huntington.

The old locality on Norwich Hill was opened for me in the summer of 1884 by Mr. Frank L. Nason, at a point a little north from the old opening. Very large crystals, the largest 29 by 7½ by 3¾ inches, were found, rarely well terminated, and of a clear gray color without the slight flesh color of some of the older crystals. They were covered with dendrites. Several fine twins, twinned parallel to $\infty P \infty$, were found. The great crystals are

1885. **Spodumene**—Continued.

often crushed, the parts much slipped on each other, being sheared many times by a force acting about at right angles to the vertical axis, and then recemented; slipping often 2 to 10 mm. They are also often bent, one 16 by 4½ by 2 inches is bent 45° without breaking. Another, the largest obtained, is broken or thus bent more than 40 times, the breaks often changing into flexures, and the whole is firmly recemented. (See fig. 5.)



FIG. 5.—Bent and faulted crystals of spodumene from Walnut Hill, Huntington, $\times \frac{1}{4}$. The lower crystal has been faulted several times and recemented in the ledge. The upper one has several small monoclinical folds.

1889. **Spodumene**. Goshen.

Mr. Alvan Barras has been excavating the spodumene in very large quantities a mile northeast of his house, opposite the sawmill at J. B. Taylor's, and New York capitalists have done some blasting at the Manning locality about a mile farther east. Samples have been sent to Paris to see if lithium could be profitably obtained from it.

1890. **Spodumene**. Chesterfield.

The best crystal of spodumene from Chesterfield—I presume from West Chesterfield Hollow—is in the collection of Columbia College, collected by Mr. A. A. Julien. It is a terminated crystal about 35 by 12 mm. in cross-section.

1890. **Spodumene**. Huntington.

Dr. E. Hitchcock sold the finest crystal ever obtained from Norwich Hill for \$50 to W. J. Knowlton, of Boston. I can not discover its present owner.

1894. Spodumene. Chester, Huntington, Goshen.

In a quartz vein in mica-schist implanted in albite.

C. Hinze: Handb. Min., p. 1121.

(All the occurrences of spodumene are in coarse pegmatite veins in mica-schist. Within these pegmatite veins the minerals containing rare elements are found in secondary veins of albitic granite, which often have a zonal arrangement with a center of smoky quartz, into which the large spodumenes sometimes project, and are then terminated.

These pegmatite veins form an outer fringe of dikes around the great central stock of granite.)

STAUROLITE.**1819. Staurotide.** Northfield.

In mica-slate 1 mile east of village, on Boston turnpike; six-sided prisms; also garnets.

E. Hitchcock: Sup. Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 436.

1823. Staurotide.

Everywhere across the State in the eastern range of mica-slate. North Wilbraham, Ludlow, Shutesbury, Leverett, Northfield.

In abundance in the western range of mica-slate in Chesterfield, Cummington, Plainfield, Hawley. In Chesterfield a mica-slate band 2 or 3 feet thick contains seven or eight distinct layers.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 219.

(I doubt the occurrence of the mineral in any of the eastern range of towns, except Northfield.)

1824. Staurotide. Norwich.

Abundant in mica-slate.

E. Emmons: *Ibid.*, Vol. VII, p. 254.

1824. Staurotide. Very common in towns about Middlefield (Emmons).

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 40.

1841. Staurotide. In mica-slate in Norwich, Chesterfield, Goshen, Hawley, and Heath.

E. Hitchcock: Geol. Mass., p. 593.

1844. Staurotide. (*Carbunculus decussatus*.) Chesterfield.

J. D. Dana: Sys. Min., p. 385.

1861. Staurolith. Chesterfield.

Large black and brownish-black crystals, accompanied by light and dark mica and albite. Sp. gr. 3.772.

SiO ₂	28.86
Al ₂ O ₃	49.19
Fe ₂ O ₃	3.20
FeO	13.32
MnO	1.28
MgO	2.24
H ₂ O	.43
	98.52

C. Rammelsberg: Pogg. Ann., Vol. CXIII, p. 599.

1877. Staurolite.

Blandford, east of Blairs Pond, in feldspathic mica-schist. The best cabinet specimens occur here in both forms of twinning. The mineral is confined to the Goshen and Conway schists and to the Devonian mica-schists of the Bernardston series in their more eastern and northern extension, especially around South Vernon.

1885. Staurolite. Whately.

Exquisite microscopical twins occur, forming with muscovite pseudomorphs after chiastolite in the argillite at contact with the tonalite.

1894. Staurolite.

The analysis of 1861, cited above, is quoted as "angeblich aus Massachusetts (Chesterfield?)."

C. Rammelsberg: Neues Jahrbuch; Beilage-Band IX, p. 480.

STIBNITE.

1823. Sulphuret of antimony. Near South Hadley (Gibbs).

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 236.

1825. Sulphuret of antimony.

Cleaveland's Min., p. 688.

1825. Sulphuret of antimony.

Robinson's Cat., p. 70.

(A doubtful occurrence.)

STILBITE.

1818. Stilbite. Deerfield.

Not abundant; associated with chabasite; crystals small, well defined.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. Stilbite. Deerfield.

Crystals appear to be right prisms, whose bases are rhombs, with angles about 60° and 120° ; rarely exceed one-tenth inch. Often grouped in foliated masses.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 224.

1824. Stilbite. Chester.

With chabasie in single, oblique, four-sided prisms with rhomboidal terminations, and grouped sometimes in bundles and globular masses and radiating from a center. Called zeolite by Professor Dewey, but does not gelatinize with acids. In fissures of veins in mica-slate about 1 mile east of meetinghouse in Chester.

E. Emmons: Loc. Min.; *ibid.*, Vol. VII, p. 254.

1835. Stilbite? Goshen.

No. 1529 in State collection; a zeolite (?) on granite from Goshen.

E. Hitchcock: Geol. Mass., p. 507.

1841. Zeolite(?). Belchertown (Three Rivers).

In gneiss with prehnite.

E. Hitchcock: Geol. Mass., p. 639.

(Should be Palmer.)

1844. Stilbite. (*Zeolus fascicularis.*) Chester.

J. D. Dana: Sys. Min., p. 328.

Bull. 126—11

1859. **Stilbite.** Goshen.

White fibrous, radiated on drusy quartz in fissure of fine-grained gneiss. Cat. Mass. Col., No. 159; Rep. on Agri. of Mass., for 1858, Appendix, p. lxviii.

1882. **Stilbite.** Chester.

On dark-gray fine-grained fresh gneiss; stout, square prisms, $\infty P \infty$, $\infty P \infty$, $0 P$ with fluted sides and slightly rounded end; wine yellow; the single prisms graduate into openly radiated bundles with deep red-brown chabasite, the two growing together so as to show them to have been formed at the same time. Also twinned tubes and cubo-octahedrons of pyrite, the latter newer and one-eighth of an inch long. The fine specimen from which these notes were taken was destroyed in the burning of the Shepard collection. It came probably from the locality cited above by Emmons.

1882. **Stilbite.** Deerfield.

This occurs generally in separate narrow fissures with comparatively fresh walls, associated only with heulandite, chabazite, calcite, pyrite, and diabantite, but it is found sometimes resting on prehnite. It appears (a) in circular forms with radiated structure 10 to 20 mm. in diameter, and up to 2 mm. thick, either spread separately or aggregated so thickly as to cover the whole surface, or in small hemispheres; Farther south, opposite Deerfield, fine globular forms as large as a marble rest upon the gashed quartz, and secondly (b) in small stout scopiform crystals, $\infty P \infty$, $\infty P \infty$, $0 P$, of dull yellow color. The first form occurs associated with calcite, and rarely chabazite; the second with heulandite and chabazite, and I examined a flat surface of the trap, 4 feet square, one-half of which was covered with radiated stilbite, at first thickly covering the surface, then separating into distinct disks, and then quite suddenly replaced along a straight line by heulandite with which was associated chabazite, and rarely the small prismatic crystals of stilbite. A third form of stilbite (c) is in interlaced crystals 4 mm. long, perfectly pellucid, with even, highly polished faces $\infty P \infty$, $\infty P \infty$, $0 P$. Under the microscope the mineral shows a fine rigid lining parallel to $0 P$, which seems to mark lines of growth, and has no effect upon the polarization. At right angles to this run (1) long lines of flat water cavities, often negative forms in whole or part, or such forms many times repeated and indicating quite rapid crystallization, and (2) sharply marked lines of multiple twinning, the whole crystal being made of fine plates which increase in number from below upward, new plates being intercalated and old ones obliterated, as in a compound coral. The new plates sometimes appear as points and increase upward with curved faces, and sometimes the old crystal develops a P-face upon which the new one is based.

Products of the decomposition of stilbite.—Kaolin (?). Many broad surfaces of the trap are covered with snow-white stellate patches of stilbite, which show all stages of the decomposition of the mineral into kaolin (?). In specimens already become snow-white and opaque, the kaolin can be seen under the microscope in minute rounded scales and aggregations of these into beaded lines, which are crowded in between the laminae of the stilbite, the latter showing no signs of change, but remaining limpid and polarizing apparently as vividly as in the freshest specimen. In other pieces where the change is nearly complete, the mass shows only aggregate polarization, and only traces of the stilbite remain.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 357.

1886. **Stilbite.** Monson.

From the north end of the Flynt quarry in gneiss. Incrusting broad surfaces with colorless radiated needles and small crystals; also in broad, laminated, flesh-colored mass filling a vein in the northwest of the quarry. Small colorless-bladed crystals in reticulated groups on chabazite.

1891. **Stilbite.** Orange, Buckland.

Orange: In broad flesh-colored radiations with prehnite on surfaces of Monson gneiss in the cutting east of the station. Buckland: In fissures in gneiss in the quarry on the railroad near Shelburne Falls, with chabasite, natrolite, epidote, and babingtonite.

STOLZITE.

1866. **Scheelite.** Manhan lead mine, Southampton.

"This mineral was handed me for determination by Mr. Clark, of Northampton. He found the few unknown crystals occupying together a cellular quartz gangue, nearly one-half inch long and three-eighths of an inch in diameter; right square prisms, imperfectly terminated by acute hemihedral pyramids; the faces are not altogether plane, presenting a dissected or unfinished appearance. Color pale, wax yellow, passing into gray. The inner portions are grayish black, with shade of blue with submetallic luster; otherwise the luster is adamantine. Before the blowpipe it decrepitates slightly, melts easily, yielding lead and dark-gray globules with borax yellow while hot gray and opaque on cooling; with salt of phosphorus yellow while hot, colorless on cooling, with excess greenish-yellow while hot, opaque to grayish when cold; with NO_5 dissolves with yellow residue, which gives with metallic zinc the reaction for wolframium.

"As scheelite and cassiterite occur in Chesterfield, we may well be encouraged to persevere in efforts to find tin in workable quantity not far distant."

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLI, p. 215.

1885. **Stolzite.**

The specimen upon which Professor Shepard made his observations was burned with his collection. The remaining specimens have passed with the Clark collection into the possession of Smith College, Northampton, and have the original label of Mr. Clark, with the note that it is the same that was submitted to Professor Shepard, and determined by him to be scheelite. The best specimen contains several groups of small crystals, $3\frac{1}{2}$ by $1\frac{1}{2}$ mm. in cross-section, black, with metallic luster and peacock tarnish, which have smooth shining faces with the form $P(111), \frac{\infty P 2}{2} (120)$. The prism has striation parallel to the intersection with the pyramid and the form agrees exactly in proportion of parts with the crystals from Zinnwald (Naumann, Pogg. Ann., Vol. XXXIV, p. 373, pls. 3, 8; Quenstedt, Min., p. 499, fig. 3).

The largest crystals are formed by the partial coalescence of several of these long square prisms, resulting in stout square prisms with deep longitudinal grooves on the prismatic faces. Moreover, these long prismatic faces are built up of smaller crystals, which are not only in parallel position, but are of common size and arranged in vertical rows between the grooves mentioned above, and they terminate above and below in sharp pyramids, thus giving the whole a peculiarly ornate gothic appearance. In part the black color extends to the surface in these larger crystals; in part, and especially toward the end, they are dull wax yellow. The partial

1885. **Stolzite**—Continued.

crystals present a greater complexity of form; the combinations $P(111)$, $\frac{\infty P 3}{2}(\pi 120)$, $\frac{2 P \frac{4}{3}}{2}(\pi 342)$, $P(111)$, $\frac{\infty P 3}{2}(\pi 120)$, $P \infty(101)$, $P(111)$, $P \infty(101)$, $\infty P 2(120)$, $\frac{3 P 3}{2}(\pi 131)$. P is rough, as if regularly picked with a needle point, $P \infty$ smooth, shining; $\infty P 3$ smooth, rounded; $P 3$ rough. The crystal showing the latter combination is remarkable for showing $\infty P 2$ holohedral and for a beautiful hemihedrism; all the pinacles at one end of the big prism running out in P , ∞P ; on the other end in P alone, with two opposite faces so developed that the pinacles all end chisel-shaped. It shows thus the same development as Naumann (loc. cit., fig. 10, fig. 4; Quenstedt, Min., p. 499), and isolated crystals of this form also occur, which have $\infty P 2$ hemihedral and all the faces developed in the same relative proportion as in Naumann's fig. 10.

The large crystals are coated by a great number of minute reddish-yellow crystals, which sometimes form a crust upon them, which on ground of imperfect blowpipe diagnosis were thought to be vanadinite by Professor Shepard. They are in parallel position with the larger crystal, and a careful examination with a strong lens shows that they have the same crystalline form—the ground pyramid with a rounded trito prism. They are, therefore, a second generation of stolzite or a later incrustation of wulfenite. With the common isomorphism and common occurrence of the two species, it is not easy to say which is the fact. The reddish-yellow color is that of the later wulfenites of the locality.

There is a specimen from Loudville in the Clark collection, nearly a decimeter square, of a massive black mineral, very heavy, with conchoidal fracture, pitchy luster, resembling black pitchstone or pitchblende.

It is delicately veined with white cerussite, and on the reverse side runs out into the quartz in stout-square prisms much like those of stolzite, which the mineral resembles strongly. It is labeled by Mr. Clark "marasmolite, Professor Shepard thinks, or perhaps copper glance," and on a separate label "black cerussite," but it proves on analysis to be stolzite.

SULPHUR.

1818. **Sulphur.** Conway, Shelburne, and Warwick.

On mica-slate.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. **Sulphur.**

Pulverulent; perhaps from decomposition of some sulphuret.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 230.

1824. **Sulphur.** Cummington.

In the singular mineral discovered by Dr. Porter (cummingtonite, Dewey). Also Middlefield and Chester (Emmons) in rock with bright-green mica.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 54.

1882. **Sulphur.** Northfield.

In cavities in decomposing pyrite layers in hornblendic gneiss on sharp east slope of Trowbridge Hill, on north line of State, in minute crystals.

1883. **Sulphur.** Leverett.

In hornblende-schist in drusy cavities lined with beautiful minute crystals.

1895. **Sulphur.** Hatfield.

At the lead mine in small globules on altered galena.

TALC.

1818. **Steatite.** Shutesbury.

(Localities said to be given on map which accompanied the article in first and second editions of this volume of the Journal, but not the later ones. I have not seen it.)

Indian pots, pipes, etc.

E. Hitchcock: Geol. Deerfield dyke; Am. Jour. Sci., 1st series, Vol. I, p. 113.

1818. **Soapstone.** Southampton lead mine.

At 670 feet in on the tunnel.

“Beautiful green soapstone, very compact, but rather softer than that kind used for inkstands.”

A. Eaton: Am. Jour. Sci., Vol. I, p. 138.

1820. **Soapstone.** Middlefield.

Discovered by E. Emmons.

Professor Dewey: Ibid., Vol. II, p. 236.

1821. **Soapstone, magnesian stone.** Middlefield.

“A quarry of this species of stone at Plainfield, in the west of Hampshire, has been wrought to a considerable extent. I have seen a house faced with it in Northampton.” (On Round Hill, occupied by Clark Institute. Should be Middlefield. See 1826, below.)

Dwight's Travels, Vol. 1, p. 34.

1821. **Steatite.** Loudville, with barite.

Cleaveland's Min., Vol. I, p. 437.

1822. **Crystalline steatite.** Middlefield.

C. Dewey: Am. Jour. Sci., 1st series, Vol. IV, p. 274; Vol. V, p. 249.

1823. **Crystalline steatite.**

Ibid., Vol. VI, p. 334.

The above citations refer to crystals of serpentine after olivine; see Chrysolite.

1823. **Steatite.**

Southampton (Cleaveland). Middlefield, in steatite (Dewey). Pelham, Rowe. Cummington (J. Porter). New Salem, bed in gneiss.

E. Hitchcock: Geol. Conn. River; *ibid.*, p. 228.

1824. **Steatite.**

Middlefield, white, green white, deep green, large folia. Chester, brown talc forming veins in mica slate (Emmons). Large bed 2 miles east of the meetinghouse; extensively quarried and transported to Boston as free-stone. Also at Worthington.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 51.

1825. **Steatite.** Zoar.

In serpentine.

Robinson's Cat., p. 78.

Zoar is a village in Charlemont. The soapstone is across the line, in Rowe.

1826. **Soapstone.**

“The house on Round Hill, in Northampton, mentioned by President Dwight, is built of soapstone—not from Plainfield, where the rock does not occur, but, as the owner informed me, principally from Middlefield.”

J. Porter: Min. Not.; Am. Jour. Sci., 1st series, Vol. X, p. 19.

1827. **Talc in steatite.** Cummington.

One-half mile north of Hubbard's leather manufactory.

A. Nash: Lead mines of Hampshire County; *ibid.*, Vol. XII, p. 260.

1828. **Steatite.** West Granville.

Good bed 1 or two miles southeast of meeting-house.

E. Hitchcock: *Ibid.*, Vol. XIV, p. 222.

1832. **Steatite.**

Rowe, white and deep green. Shutesbury, south part. Wendell, south part. New Salem, 2 miles east of village.

Not so good on east as on west side of river.

E. Hitchcock: *Geol. Mass.*; *ibid.*, Vol. XXII, p. 32.

(The Wendell occurrence is a large boulder northwest of Locks Pond.)

1833. **Steatite.**

Middlefield, northeast part; one of the finest beds in the State; contains dolomite. Blandford, wrought. Granville, two beds. Zoar, two varieties—white and deep green. Rowe, two varieties.

E. Hitchcock: *Geol. Mass.*, p. 32.

1835. **Steatite.** Middlefield.

Mr. William H. Butler has just opened a new quarry there.

Ed. note: *Am. Jour. Sci.*, Vol. XXVII, p. 382.

1835. **Steatite.** Rowe, Zoar, Middlefield, Granville, Shutesbury, New Salem.

In gneiss.

E. Hitchcock: *Geol. Mass.*, p. 357.

1841. **Steatite.** Above localities.

Middlefield, delicate green. The variety of talc called nacrite, one-half mile west of the meetinghouse; in talcose slate.

Ibid., pp. 610, 613.

1844. **Steatite.** Above localities.

E. Hitchcock: *Ex. Geol. Map.*

1876. **Talcite.** Rowe, Chester, Zoar.

C. U. Shepard; *Cat. of Min.* within 75 miles of Amherst.

1891. **Steatite.** Richmond, N. H. Harris's quarry.

In beautiful coarse radiated masses and in large amount, derived from the alteration of the anthophyllite (gedrite) described on page 86. It is quarried extensively and carried to Athol, where it is worked.

TETRAHEDRITE.

1835. **Gray copper**

"I have seen a specimen from Brimfield; I infer that it originated from gneiss."

E. Hitchcock: *Geol. Mass.*, p. 399.

Doubtful occurrence.

THOMSONITE.

1841. See Natrolite.

TITANITE.

1824. **Silico-calcareous oxide of titanium.** Chester.

Imperfect prisms, light brown, with augite and actinolite; also in syenite.

E. Emmons: *Loc. Min.*; *Am. Jour. Sci.*, 1st series, Vol. VII, p. 254.

1824. Silico-calcareous oxide of titanium. Middlefield.

Imperfect prisms, rather lighter colored, but much resembling that of Brattleboro, Vt.

C. Dewey: Geol. Berkshire County; *ibid.*, p. 58.

1835. Spkene.

Middlefield and Chester, in hornblende slate. Pelham, in gneiss.

E. Hitchcock: Geol. Mass., pp. 381, 398.

1841. Spkene.

In hornblende-slate in Middlefield and Chester.

Ibid., p. 624.

1844. Spkene. (*Rutilus obliquus*.) Pelham.

J. D. Dana: Sys. Min., p. 421.

1876. Titanite. Pelham, Belchertown, Chester.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 7.

1882. Titanite. Pelham.

Rare, in pale-yellow to chocolate-colored crystals, 1 mm. to 5 mm. in length; in specimens of feldspar labeled albite by Professor Shepard in Amherst College collection; also in the common gneiss 2 miles north of the asbestos mine in flat, well-formed crystals, and in small grains everywhere in Monson gneiss.

1892. Titanite. Pelham.

Honey-yellow crystals ($G. = 3.541$, Pirsson). Chester, with diasporc.

E. S. Dana: Sys. Min., p. 715.

TOPAZ.

1824. Topaz(?). Middlefield, Chester.

Middlefield: Small crystals in serpentine; some prismatic and tetrahedral, yellow, brittle, $H. > 7$; lying loosely among disintegrated mineral.

Pycnite (subspecies); Chester: In gneiss boulders; bluish-green, 6-sided prisms terminated by planes, and angles truncated; imperfectly foliated perpendicular to the axis; luster of lateral planes vitreous; infusible; sp. gr. toward 4; less hard than beryl, which it resembles; largest crystal $1\frac{1}{2}$ by $1\frac{1}{2}$ inches; several at times united parallel to each other (Emmons).

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 40.

[Not elsewhere cited; the first probably quartz, the second was probably apatite.]

1825. Pycnite.

In detached pieces of gneiss resembling beryl.

Robinson's Cat., p. 42.

1825. Topaz(?). Goshen.

See Beryl.

E. Hitchcock: *Ibid.*, Vol. IX, p. 180.

TORBERNITE.

1879. Torbernite. Chesterfield Hollow.

Associated with spodumene and resulting from change of zircons containing uranium.

A. A. Julien: Spodumene and its alterations; Ann. N. Y. Acad. Sci. and Arts, Vol. I, p. 354.

TOURMALINE.

1811. **Tourmaline.** Goshen.

Lately discovered on estate of Mr. Weeks, of this city, to whom we are indebted for the discovery. (Short description.)

Dr. Bruce: Bruce's Jour., Vol. I, p. 123.

1818. **Schorl**, black. Pelham, Shutesbury, Orange.

E. Hitchcock: Geol. Deerfield; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1819. **Tourmaline.** Chesterfield.

Notes on locality. Discovered by Dr. Hunt.

On tourmalines, etc., at Chesterfield.

Col. G. Gibbs: Ibid., Vol. I, p. 348.

1822. **Tourmaline.** Plainfield.

Good crystals in quartz.

Dr. J. Porter: Ed. note; *ibid.*, Vol. IV, p. 55.

1824. **Tourmaline.** Cummington.

Black in milky quartz; uncommonly fine.

J. Porter: Loc. Min.; *ibid.*, Vol. VII, p. 252.

1824. **Schorl**, blue. Norwich (now Huntington).

Near white rocks one-half mile west and visible from Pitchers Bridge in coarse granite.

E. Emmons: Loc. Min.; *ibid.*, p. 254.

1824. **Tourmaline.** Middlefield, Chester, Norwich.

In granite veins in mica-schist.

Indicolite and green tourmaline in vein of granite in mica schist with silicious feldspar (albite), beryl, prismatic mica, green feldspar, and rose quartz. One green crystal 2 inches long and blue inside; 2 miles south of meetinghouse in Chester (Emmons).

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 42.

1824. **Schorl.** Pelham.

In large masses not regularly crystallized, but exhibiting a crystalline tendency. (At asbestos quarry.)

C. U. Shepard: Loc. Min.; *ibid.*, p. 235.

1826. **Tourmaline.** Worthington.

Well crystallized, radiated, glassy, black, of great elegance. Plainfield.

J. Porter: Min. Not.; *ibid.*, Vol. X, p. 18.

1827. **Schorl.** Williamsburg.

In veins of granite in mica slate and in granite lying contiguous to mica slate; terminated. Chesterfield. Frequently stellated.

A. Nash: Lead mines of Hampshire County; *Ibid.*, Vol. XII, p. 259

1828. **Tourmaline.** Chesterfield.

"The vein has been laid open 10 to 12 feet in length. I found Mr. Clark the proprietor, very accommodating and reasonable in his charges for minerals. He will pack boxes for gentlemen at a distance who request it."

E. Hitchcock: Loc. Min.; *ibid.*, Vol. XIV, p. 215.

1828. **Tourmaline.** Norwich (now Huntington).

Near whetstone quarry on west slope of Walnut Hill.

Fine black schorl crystals 1 to 2 inches long and completely covering the convex side of a mass of mica-schist a foot long and 10 inches wide.

E. Hitchcock: *Ibid.*, p. 220.

1829. **Tourmaline**, green. Chesterfield.

Analysis by Gmelin; green variety; sp. gr., 3.102.

BO ₂	3.88
SiO ₂	33.80
Al ₂ O ₃	39.61
Fe ₂ O ₃	7.31
MnO ₂	2.88
NaO.....	4.95
Loss.....	.78
	98.33

Ibid., Vol. XV, p. 389.

1835. **Tourmaline**. Chesterfield.

The vein is about 1 foot in width; crystals small, rarely perfect, deeply striated, much curved often, and rifted by cross seams into which the quartz is thrust; green crystals with red center, especially in quartz; single crystals in albite often pure red or green.

C. U. Shepard: Min., Vol. II, 2d ed., p. 245.

1841. **Tourmaline**. Chesterfield.

Many crystals are in a state of internal disintegration; the interior is then often found in a fibrous state.

Teschemacher: Bost. Jour. Nat. Hist., Vol. IV, p. 36.

1841. **Acmite?** Chester.

E. Hitchcock: Geol. Mass., p. 614; also No. 2180 in Cat. of State Col., p. 815, and No. 120, under "Talcose slate," in Final Cat. of State Col. Sixth Ann. Rep. Mass. Board of Agri., App., p. xlv, 1858.

(Referred with doubt to acmite, but finally catalogued as hornblende. It is the black hexagonal tourmaline from the north emery mine.)

1841. **Schorl. Tourmaline**.

Not common in mica-slate; one large slab found in Norwich with crystals standing out upon the surface of the size of a goose quill; generally acuminate. Almost every variety found in the granite; full description given. Common schorl, Pelham.

E. Hitchcock: Geol. Mass., pp. 606, 637, 702.

(The above slab is in the Amherst collection.)

1844. **Tourmaline**. (*Turmalus rhombohedrus*.) Chesterfield, Goshen.

J. D. Dana: Sys. Min., p. 389.

1852. **Tourmaline**. Goshen.

Regular twins; prisms crossing at right angles; rare; a similarity in composition has been observed between the tourmaline and the rock which incloses it; e. g., rubellite in lepidolite; soda-tourmaline in albite.

C. U. Shepard: Min., 3d ed., p. 221.

1860. **Tourmaline**.

Zu Chesterfield in Massachusetts kommen grüne Tourmaline mit rothen Kernen in Topaz vor. (Error.) Seyfert und Söchting (A. A. O., p. 206).

Söchting: Einschlüsse von Mineralien, p. 199.

1865. **Tourmaline**. Chester emery mine.

Highly prevalent throughout the whole vein, especially in North Mountain; more frequent near sides of vein; at some places interlaminated through its entire mass. Crystals often several inches long, fascicular and radiating; longer axis conforming to the bedding; six-sided, unterminated, brownish black.

C. U. Shepard: Report Chester emery mine, p. 11.

1866. Radiated tourmaline. Warwick. Grace Mountain.

C. U. Shepard: Am. Jour. Sci., 2d series, Vol. XLII, p. 248.

1866. Tourmaline. Chester.

With emery, as at Naxos.

J. L. Smith: Ibid., p. 92.

1876. Tourmalinite, indicolin, rubellin.

Tourmalinite: Black, Pelham; green, Chesterfield, Goshen; blue (indicolin), Goshen, Chester; red (rubellin), Chesterfield, Goshen.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst, p. 6.

1882. Tourmaline. Northfield, Brush Mountain.

Abundant crystals; termination R,— $\frac{1}{2}$ R.

W. E. Webster's collection; Northfield.

1883. Tourmaline. Pelham, at the asbestos mine.

Masses of black tourmaline occur 10 to 20 inches across, which afford at times very large imperfect crystals 4 to 8 inches in length, and quite frequently fine, small, perfectly terminated specimens showing the two flat rhombohedra and uniformly a small brilliant O P face. These break out of the compact mass of the same mineral, but a film of a compact talc-like mineral surrounds the termination; also small crystals of a deep red-brown occur. The mineral also forms curious micropegmatitic intergrowths with the basic feldspars.

1885. Tourmaline. Huntington.

At the new opening for spodumene on Norwich Hill only black tourmaline was found, and that was not abundant. One great crystal 17 inches long, 4.7 inches across at the large end, is nearly cylindrical for two-thirds its length and then tapers in the last third to a rude point, as if a large hand had rudely molded it, the deep imprint of the fingers remaining at the other end. It is terminated by O P, the edge of which is replaced by the small faces of a flat rhombohedron.

1891. Tourmaline. Chesterfield.

Crystals of tourmaline $1\frac{3}{4}$ inches across and 4 inches long, mottled green and blue outside, deep green on the inside. From Macomber's ledge; and the finest from this locality are in the collection of Columbia College. They were collected by Mr. A. A. Julien.

1891. Tourmaline. Chester.

Quite fine black doubly terminated crystals 1 inch long, short and stout like those from Monroe, Conn. In coarse chlorite schist in railroad cutting near village.

1894. Tourmaline. Chester.

The radiated and fasciculite-like tourmaline occurs finely at the new mine just across the road and river to the north of the old mine. I have reexamined the mineral and find its prisms measure 60° . It is uniaxial and deep emerald green by transmitted light. A chemical examination made by Mr. Arthur J. Hopkins, instructor in chemistry, gave silica 32.30 and a strong test for boron. This examination was made because the mineral has recently been called hornblende again, which it much resembles in the smooth faces and hexagonal form of the prisms.

1894. Tourmaline. Northfield.

An interesting locality has recently been opened by blasting by Mr. C. H. Webster, of Northfield. Leaving the gulf road at school No. 6, and going east a half mile on the Erving road, and then south a fourth of a

1894. **Tourmaline**—Continued.

mile, the crystals are found in a quartz vein which lies in the line of the great Northfield fault. The crystals are 10 to 20 mm. wide and the longest about 8 cm. long. They are inclosed in white quartz and are much broken and recemented. They show the crystalline faces $\infty R 2$, $\infty R \frac{5}{4}$, ∞R , $-\frac{1}{2} R$, $-2 R$.

1894. **Tourmaline**. Warwick.

High up on Mount Grace in hornblende-schist the mineral occurs abundantly in radiating groups about an inch across of shining black striated needles. It occurs also diverging in both directions from a plane which is only marked by a line of fine black grains and from which the needles go out at right angles. The tourmalines have often absorbed all the iron from the surrounding rock, and a fine granular quartzite slightly tinted by epidote remains.

TREMOLITE.

See Zoisite, 1818, and Amphibole, 1835.

TRIPHYLITE.

1850. **Staurotide**. Norwich (now Huntington).

Spodumene locality on farm of C. Hartwell. Black, semimetallic luster; crystals $1\frac{1}{2}$ inches in breadth. New crystalline form.

J. D. Dana: Am. Jour. Sci., 2d series, Vol. X, p. 121.

1851. **Phosphate of iron, manganese, lithia**. Norwich.

In quartz with spodumene; crystals one-fourth to above an inch in length. At first supposed to be black staurotide, with which it is isomorphous; differs from triphyline in absence of cleavage.

J. D. Dana: On the physical and crystallographical characters of the phosphate of iron, manganese, and lithia of Norwich; Ibid., p. 101.

1851. **Triphylite**. Norwich.

Chemical examination. Sp. gr. 2.876.

	No. 1.	No. 2.
PO ₅	41.35	44.04
Fe ₂ O ₃	27.36	26.02
MnO ₃	24.70	23.30
Al ₂ O ₃	Trace.	Trace.
LiO.....	2.27	2.20
CaO.....	1.97	1.61
MgO.....	Trace.	Trace.
H ₂ O.....	2.07	2.07
	100.01	100.14

RO, 3R₂O₃, 3PO₅.

W. J. Craw: Chemical examination of a phosphate of iron, manganese, and lithia from Norwich, Mass.; *ibid.*, Vol. XI, p. 99.

1852. **Triplite (alluaudite?)**. Norwich.

Figured and angles given; considered monoclinic; described.

C. U. Shepard: On the triplite (alluaudite) of Norwich; Proc. Am. Assoc. Adv. Sci., Vol. VI, p. 234.

1853. **Triplite**. Norwich.

The crystals are referred by Shepard to the monoclinic system; angles given.

The above article noticed in Am. Jour. Sci., 2d series, Vol. XV, p. 445. Editor's note. The reviewer defends the rhombic crystallization of the mineral.

1853. Triphyline. Norwich.

The triphyline on alteration loses its alkali takes up water and oxygen, the iron and manganese become peroxides. The mineral from Norwich is of this kind.

Scientific intelligence; Am. Jour. Sci., 2d series, Vol. XV, p. 445.

1854. Phosphate of iron and manganese.

First observed by Dr. E. Hitchcock, jr., and Mr. Hartwell. Analysis; considered it an altered mineral.

J. W. Mallet: Ibid., Vol. XVIII, p. 33.

1862. Triphyline. Norwich.

The center of some of the altered crystals is found to be green and distinctly cleavable and to be triphyline—its first identification in this country.

G. T. Brush: Ibid., Vol. XXXIV, p. 402.

1879. Triphylite. Norwich.

Analysis of the unaltered interior of a crystal. Color grayish-green; sp. gr. 3.534.

	No. 1.	No. 2.	No. 3.
P ₂ O ₅	44.72	44.80	44.76
FeO	26.40	26.40	26.40
MnO	17.87	17.80	17.84
CaO	.16	.33	.24
MgO	.49	.45	.47
Li ₂ O	9.37	9.34	9.36
Na ₂ O	.32	.38	.35
H ₂ O	.53	.30	.42
	99.86	99.80	99.84

Li Fe PO₄.

S. L. Penfield: Chemical composition of triphylite; ibid., 3d series, Vol. XVII, p. 226.

1891. Triphylite. Huntington.

Most of that from Huntington is altered to the center by the peroxidation of the manganese and iron and the removal of most of the lithia. Fine large crystals are sometimes found attached laterally to large spodumene crystals.

URACONITE.**1852. Uranochre.** Chesterfield.

C. U. Shepard: Min., 3d ed., p. 144.

1879. Uranochre. Chesterfield Hollow.

In fissures in spodumene resulting from change of autunite and torbernite.

A. A. Julien: Spodumene and its alterations, p. 354.

URANITE.

See Autunite.

VANADINITE.**1866. Vanadinite.** Manhan lead mine, Southampton.

The very rare crystals of stolzite are at times partially incrustated by a red-brown somewhat botryoidal mineral, which affords the blowpipe reaction of vanadinite, though the quantity employed in the trial did not permit a complete verification of this inference."

C. U. Shepard: On the scheelite at the Southampton lead mine; Am. Jour. Sci., 2d series, Vol. XLI, p. 215.

1885. **Vanadinite.**

A careful examination of the reddish-yellow crusts upon the original specimen of stolzite in the Clarke collection in Smith College shows that they are made up of quadratic crystals $P(111) \frac{\infty P 3}{2} (\pi 130)$ of stolzite or wulfenite; probably the latter.

VERMICULITE.

See Jefferisite.

1882. **Diabantite-vermiculite.** Deerfield. Cheapside Railroad cutting, in trap.

The steps of the process by which the diabantite changes to a vermiculite are given above under Diabantite. The material, although quite characteristic, hardly requires a separate specific name.

B. K. Emerson: The Deerfield dyke and its minerals; Am. Jour. Sci., 3d series, Vol. XXIV, p. 201.

VESUVIANITE.

1824. **Idocrase.**

Hyacinth-red; luster vitreous; fracture uneven (Emmons). Imperfect crystals, sometimes nearly one-fourth of an inch in diameter; prism terminated by low pyramids. Chester, with actinolite, epidote, chlorite; also Worthington (Emmons).

C. Dewey: Geol. Berkshire County; Am. Jour. Sci., 1st series, Vol. VIII, p. 44.

Doubtful occurrence.

VILLARSITE.

1882. **Villarsite.** Pelham.

Much of the chrysolite at the asbestos mine has lost its disseminated ore, become hydrated, and exactly resembles this mineral. It has a pale olive-green color, becomes friable, and the grains are softer than olivine.

VIVIANITE.

1883. **Vivianite.** Hadley.

In the insect-bearing leaf beds which crop out in the east bank of the Connecticut River 100 rods above the bridge over the Fort River, near its mouth. These leaf beds are cross sections of old beds of the Fort River. The vivianite occurs as a replacement of leaf stems, and disseminated in the fine sand in quite large patches. It often coats the wings of insects.

WAD.

1820. **Oxide of manganese.** Deerfield, Leverett.

E. Hitchcock: Am. Jour. Sci., 1st series, Vol. II, p. 374.

1823. **Oxide of manganese.** Leverett.

In alluvial soil forming a bed 5 or 6 inches thick a few inches below the surface; granular. Deerfield, crusts on quartz and mica-slate.

E. Hitchcock: Geol. Conn. River; *ibid.*, Vol. VI, p. 235.

1833. **Oxide of manganese.** Leverett, Whately, Conway.

Up to 1 foot thick.

E. Hitchcock: Geol. Mass., p. 123.

1841. **Oxide of manganese or wad.**

Bog deposit in Leverett, Whately, Conway; sometimes up to 1 foot thick.
Ibid., p. 318.

1876. **Wad.** Leverett lead mine.

As dendrites and as aggregates in cavities of minute black shining scales, which in a few days lost their high luster and sank into a brownish-black powder having the properties of common wad.

1882. **Wad.** Deerfield.

Occurs scattered over much of the prehnite in dots often massed together over a surface otherwise clean, in long diamond shapes, the shadows of elongated calcite scalenohedra which have disappeared.

B. K. Emerson: The Deerfield dyke; Am. Jour. Sci., 3d series, Vol. XXIV, p. 351.

WASHINGTONINE.

1876. **Menaccanite** var. **washingtonin.** Chester.

C. U. Shepard. Cat. of Min. within 75 miles of Amherst, p. 7.

WASHINGTONITE.

See Menaccanite.

WERNERITE.

1824. **Scapolite.** Chester.

C. Dewey. (See Zoisite, 1824.)

1825. **Scapolite.** Charlemont.

J. Porter. (See Zoisite, 1825.)

1826. **Scapolite.** Goshen.

J. Porter. (See Zoisite, 1826.)

1835. **Scapolite.** Westfield.

C. U. Shepard. (See Oligoclase, 1835.)

Is a coarse granular plagioclase near oligoclase. Specimen preserved in Mass. State Col., Sec. XIII, No. 32. Cat. in Mass. Agri. Rep. 1859, App., p. xlv.

1841. **Scapolite.** Chester.

E. Hitchcock: Final Rep., p. 606. (See Zoisite, 1824.)

1841. **Scapolite** or **petatite.**

E. Hitchcock: Final Rep., p. 618. (See above, 1835.)

1844. **Scapolite.** (*Scapolus pyramidalis*.) Chester.

J. D. Dana: Sys. Min., p. 357.

WULFENITE.

1811. **Molybdate of lead.** Loudville.

Description.

Wm. Meade: Bruce's Jour., Vol. I, p. 151.

1823. **Molybdate of lead.** Above quoted.

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 234.

1835. **Yellow lead ore.** Pyramidal lead baryta. Loudville.

Rare.

C. U. Shepard, Min., Part II, Vol. II, p. 285.

1885. **Wulfenite.**

Was obtained in considerable abundance at the last opening of the mine at Loudville. The finest suite of crystals in the Clark collection in Smith College.

Color smoke gray, lemon yellow, orange yellow to yellowish red. The gray, yellow, and orange crystals are present respectively in different crystallographic types. The two former colors are comparatively rare; the orange deepens to a tint only a shade less deep than the Phoenixville crystals. The luster is vitreous to resinous in the red shades; subadamantine in the other colors.

The crystals are distantly attached by their edges to the cavernous quartz, and only very rarely occur in continuous crusts, as at Phoenixville. This appears in the deep-red type, which then can scarcely be distinguished from the Phoenixville occurrence, except by the lesser luster of certain faces. They are thick to thin-tabular, the largest 10 mm. across—average 5 mm. At times a delicate groove is carried around the $0P$ face near its edge on $P\infty$ like the groove around the edge of a book cover; rarely in the smoke-gray crystals a deep claret-colored line occupies the same position and extends through the thickness of the crystal. At times a lemon-colored crystal is increased by an outward band of orange-colored material. The crystals occur in four distinct types. The smoke-gray crystals, which have a shade of yellow in them and are opaque from included foreign substance, are marked by the absence of hemihedral faces and the prevalence of hemimorphism. They are in thin tables and the rims of the crystals are occupied by faces of the zones of P and $P\infty$ in about equal degree. A few of the clear lemon-yellow crystals are of this type. The largest crystals are $\frac{3}{4}$ inch square.

Combinations represented:

1st. $0P$ (001), $\frac{1}{16}P\infty$ (1, 0, 16), $\frac{1}{12}P\infty$ (1, 0, 12), $\frac{2}{3}P\infty$ (205), $P\infty$ (101), $\infty P\infty$ (100), $\frac{1}{3}P$ (113), ∞P (110), $\infty P3$ (310).

2d. $0P$ (001), P (111), $\frac{1}{3}P$ (113), $\frac{1}{16}P\infty$ (1, 0, 16), $P\infty$ (101), ∞P (110); hemimorphic, the other end showing only $0P$ (001).

3d. $0P$ (001), $\frac{4}{3}P$ (443), $\frac{3}{2}P$ (332), $2P221$, $\frac{1}{2}P\infty$ (102), $\infty P\infty$ (110), mPn undetermined; hemimorphic. $\frac{4}{3}P$ (443) is new; angle on $0P$ (001) observed $71^{\circ}15'$; calculated $71^{\circ}25'4''$.

4th. $0P$ (001), $\frac{1}{16}P$ (1, 1, 16); hemimorphic: $0P$ (001); alone below.

The second type is lemon yellow, thick, tabular, generally neither hemimorphic nor hemihedral, with few faces, and with the $P\infty$ zone predominant, but the P zone well marked. Combinations are:

1st. $0P$ (001), P (111), $\frac{1}{16}P$ (1, 1, 16), $\frac{1}{2}P\infty$ (102).

2d. $0P$ (001), $P\infty$ (101); hemimorphic: below is $0P$ (001), $\frac{7}{25}P\frac{7}{2}$ ($\pi 7, 1, 75$) $\varphi \vee c = 8^{\circ}20'$.

The third type is of rich orange-red and very rare. The crystals are almost perfect cubes of the base and the trito-prism $\frac{\infty P3}{2}$ ($\pi 310$) with generally a trace of the second pyramid $P\infty$ (101). A beautiful specimen covered with cubes of this type is in the cabinet of Smith College. Thick tables with rounded edges may be associated with this type; they seem made up of $0P$ (001), ∞P (110), $\frac{\infty P3}{2}$ ($\pi 310$), $P\infty$ (101).

The fourth type is by far the most abundant. The crystals are an orange yellow to deep orange—almost red—and are in broad square plates, never very thin, and bounded by the faces of $P\infty$ (110), which rarely occur alone with $0P$ (001), but which are always so predominant as to decide the habit of the crystal. The rounded, polished face of the trito-prism $\frac{\infty P3}{2}$ ($\pi 310$) is rarely absent. P (111) and a long series of other

1885. **Wulfenite**—Continued.

faces appear only in traces. $0\ P\ (001)$ is, however, generally not a true face, but is made up of a series of flat pyramids.

Typical combinations are:

1st. $0\ P\ (001)$, $P\ \infty\ (101)$.

2d. $0\ P\ (001)$, $P\ \infty\ (101)$, $P\ (111)$.

3d. $0\ P\ (001)$, $P\ \infty\ (101)$, $\frac{\infty\ P\ 3}{2}\ (\pi\ 310)$.

4th. $0\ P\ (001)$, $P\ \infty\ (101)$, $\infty\ P\ 3\ (\pi\ 310)$, $\frac{\infty\ P\ \frac{6}{5}}{2}\ (\pi\ 650)$.

5th. $0\ P\ (001)$, $P\ \infty\ (101)$, $\frac{\infty\ P\ 3}{2}\ (\pi\ 310)$, $\frac{1}{16}\ P\ (1, 1, 16)$, $\frac{1}{12}\ P\ (1, 1, 12)$, $\infty\ P\ \infty\ (100)$, $\infty\ P\ (110)$, $P\ (111)$, $\frac{1}{3}\ P\ (113)$.

6th. $0\ P\ (001)$, $\frac{1}{16}\ P\ \infty\ (1, 0, 16)$, $\frac{\infty\ P\ 3}{2}\ (\pi\ 310)$, $P\ \infty\ (101)$; hemimorphic; the other end = $0\ P\ (001)$.

7th. $0\ P\ (001)$, $\frac{1}{12}\ P\ (1, 1, 12)$, $P\ \infty\ (110)$, $P\ (111)$, $\frac{1}{3}\ P\ (113)$; hemimorphic; the other end = $\frac{1}{16}\ P\ (1, 1, 16)$, $0\ P$. $\frac{1}{16}\ P\ \vee\ 0\ P = 5^\circ 54'$; $\frac{1}{12}\ P\ \vee\ 0\ P = 7^\circ 27'$.

The following is a list of the forms observed, with a word of description of the faces:

$2\ P\ (221)$, d. rare, shining.

$\frac{3}{2}\ P\ (332)$, r. rare, shining.

$\frac{4}{3}\ P\ (443)$, γ rare, shining (new).

$P\ (111)$, n. shining, small.

$\frac{1}{3}\ P\ (113)$, s. shining, small.

$\frac{1}{12}\ P\ (1, 1, 12)$, θ dull, curved (new).

$\frac{1}{16}\ P\ (1, 1, 16)$, w dull, curved.

$P\ 3\ (131)$, λ (new).

$P\ \infty\ (101)$, e. most common, large, dull, rarely shining.

$\frac{2}{5}\ P\ \infty\ (205)$, z. rare.

$\frac{1}{2}\ P\ \infty\ (102)$, u. dull.

$\infty\ P\ (110)$, m. narrow, shining.

$\infty\ P\ \infty\ (100)$, a. narrow, rough.

$0\ P\ (001)$, c. dull.

$\infty\ P\ 3\ (130)$, g. common, shining, rounded.

$\infty\ P\ \frac{6}{5}\ (650)\ \nu\ (?)$, common, notched.

$\frac{7}{15}\ P\ 7\ (7, 1, 75)$, φ rare, dull.

$\frac{1}{16}\ P\ \infty\ (1, 0, 16)\ b$.

$\frac{1}{12}\ P\ \infty\ (1, 0, 12)\ \beta$.

The face $\infty\ P\ \infty\ (100)$ is rarely present when the rounded $\frac{\infty\ P\ 3}{2}\ (\pi\ 430)$ occurs, but in its place a trito-prism turned out but a little from the position of the proto-prism and regularly notched like the so-called milling of a coin by the oscillatory repetition of $\infty\ P\ 3$ and $\infty\ P$. It can not be measured and I have assigned it doubtfully to $\infty\ P\ \frac{6}{5}$, from which it can not widely differ.

Wulfenites of the yellow type rest on stolzite, and a crust of minute reddish crystals on the same is probably also wulfenite in the form $P\ (111)$ $\frac{\infty\ P\ 3}{2}\ (\pi\ 130)$.

Analysis of the wulfenite detects chromium, but no vanadium. Paragenesis:

1. Calcite,

Quartz,

Wulfenite,

Pyromorphite.

2. Galena,

Quartz,

Stolzite,

Wulfenite.

1885. **Wulfenite**, alteration product of. Manhan lead mine, Loudville.

There is a single specimen in the Clarke collection labeled "Cotunnite, according to Professor Shepard," which possesses the following peculiarities: It is in thin, quadratic, and octagonal plates resembling exactly the thin, pale, yellow type of the wulfenite, but is exteriorly snow-white and opaque; in the interior, however, it is translucent, pale, yellow, with resinous luster.

ZIRCON.

1820. **Zircon**. Brimfield.

In adularia; found in a well near the residence of the late Gen. William Eaton by his daughter. Color of smoky quartz; four-sided prisms with four-sided ends.

A. Eaton: Index, p. 94.

1823. **Zircon**. Brimfield, in gneiss (Eaton).

E. Hitchcock: Geol. Conn. River; Am. Jour. Sci., 1st series, Vol. VI, p. 220.

1825. **Zircon**. Brimfield.

Robinson's Cat., p. 39.

1876. **Zirconite** var. **cyrtolin**. Ware.

C. U. Shepard: Cat. of Min. within 75 miles of Amherst College, p. 6.

1879. **Zircon**. Chesterfield Hollow.

Rich in uranium; minute double pyramids, rarely three-sixteenths of an inch in diameter; in albitic granite; rare but perfect crystals in quartz, core of vein.

A. A. Julien: Ann. N. Y. Acad. Sci. Arts, Vol. I, p. 351.

1879. **Oerstedite**. West Chesterfield Hollow.

Frequently found in black octahedra, not only implanted on the outer planes of these pseudomorphs, but also inclosed in the yellow mixture of cymatolite and muscovite.

A. A. Julien: Ibid., p. 329.

1879. **Cyrtolite**. Walnut Hill, Huntington.

In albitic granite in central quartz core of vein.

A. A. Julien: Ibid., pp. 327, 351, 352.

1883. **Zircon**. Pelham asbestos quarry.

In tourmaline and compact plagioclase (andesite and anorthite), in Pelham asbestos quarry. Crystals just visible to the eye; bright, transparent, red hyacinths with polished faces, long quadratic prisms doubly and complexly terminated P, 3 P, 3 P 3. These are with the microscope red to olive-green by transmitted, red to amber by reflected, light; also colorless adamantine "jargons," showing with transmitted light a faint reddish tinge.

ZOISITE.

1818. **Tremolite**. West part of Leyden, near Green River.

In mica slate. Very abundant.

E. Hitchcock: Geol. Deerfield Dyke; Am. Jour. Sci., 1st series, Vol. I, p. 114.

1823. **Tremolite, Zoisite**. Leyden.

"A mineral has been found at Leyden in great quantities associated with quartz, limestone, etc., and sometimes forming the gangue of the red oxyd of titanium. * * * Also at Colerain (?), at Shelburne (?), at Conway (?),

1823. **Tremolite, Zoisite**—Continued.

at Goshen, and in various instances in vast abundance. This mineral has generally been called tremolite, and sometimes zoisite, but it is probably scapolite."

E. Hitchcock: Geol. Conn. River.; *ibid.*, Vol. VI, pp. 223, 225.

1824. **Scapolite.** Goshen.

Scapolite of a silver-gray color associated with quartz. The surface of the crystals is longitudinally striated and generally dull, but on being broken they exhibit a structure distinctly foliated with a shining luster. Published as tremolite in Vol. VI, Am Jour. Sci.

J. Porter: Loc. Min.; *ibid.*, Vol. VII, p. 252.

1824. **Zoisite.** Chester.

Gray, flattened prisms, striated.

C. Dewey: Geol. Berkshire County; *ibid.*, Vol. VIII, p. 44.

1824. **Scapolite.** Chester.

Gray and white; pearly luster; scratches glass; sometimes four-sided prisms; generally irregular, often intersecting variously; melts to porous yellow-white glass with ease. Chester, with hornblende, augite, etc.; resembles tremolite.

C. Dewey: Geol. Berkshire County; *ibid.*, 1st series, Vol. VIII, p. 44.

1824. **Scapolite.** Southwest of Goshen.

Crystals several inches long. Surface striated, foliated; longitudinal fracture, shining, even; a metallic luster, the color a lively silver-gray; splintery crystals sometimes curved and crystals curiously interlaced; some smaller crystals with shining faces and nearly transparent. Here, as in Chesterfield, in white quartz.

J. Porter: *Ibid.*, Vol. VIII, p. 233.

1825. **Zoisite.** Hawley, near Iron Works.

In veins of quartz in hornblende rock. "It surpasses in beauty any which I ever beheld."

C. U. Shepard: Bost. Jour. Phil. and Arts, Vol. III, p. 609.

1825. **Scapolite.**

Very abundant by the roadside about a mile east of Hall's Tavern, Charlemont (Dr. H. M. Wells, of Windsor).

J. Porter: Loc. Min.; *ibid.*, Vol. IX, p. 54.

1826. **Zoisite.** Worthington.

Remarkably beautiful.

J. Porter: Am. Jour. Sci., Vol. X, p. 18.

1826. **Scapolite.** Goshen.

J. Porter: *Ibid.*, Vol. X, p. 18.

1827. **Zoisite.** Worthington, Conway, Chesterfield.

A. Nash: Lead mines of Hampshire County; Am. Jour. Sci., 1st series, Vol. XII, p. 259.

1828. **Zoisite.** Hawley (C. U. Shepard), Chester, Leyden.

Dirty gray with rutile.

Robinson's Cat., pp. 42, 57.

1828. **Zoisite.** Chesterfield.

One mile north of meetinghouse on land of Mr. Searl.

With kyanite and anthophyllite.

E. Hitchcock: Loc. Min.; *ibid.*, Vol. XIV, p. 216.

1835. **Zoisite.** Goshen, Hawley, Middlefield, Chester, Chesterfield, Conway, Windsor, and especially in large quantities in North Leyden.

E. Hitchcock: Geol. Mass., p. 346.

1835. **Zoisite.** Hawley.

Very beautiful gray crystals of small diameter compared with their length, at Hawley, penetrating small beds of quartz in hornblende rock. Goshen and Williamsburg in veins in granite in mica-slate.

C. U. Shepard: Min., 1st edition, Vol. II, p. 184.

1836. **Zoisite.** Williamsburg.

SiO ₂	40.21
Al ₂ O ₃	25.59
Fe ₂ O ₃	8.55
CaO	23.28
H ₂ O	1.71
	99.34

T. Thompson: Outlines Min., Vol., I, p. 271.

1841. **Zoisite.** Goshen, Hawley, Middlefield, Chesterfield, Conway, especially Heath and north part of Leyden.

E. Hitchcock: Geol. Mass., p. 606.

1841. **Scapolite.** Chester (Emmons).

In veins in mica slate associated with hornblende, pyroxene, and garnet, but the crystallization is generally confused and indistinct (Emmons's Min.).

E. Hitchcock: Geol. Mass., p. 606.

1844. **Epidote (Zoisite).** (*Carbunculus rhombohedrus*.) Chester, Chesterfield, Heath, Leyden, Williamsburg.

J. D. Dana: Sys. Min., p. 379.

1857. **Zoisite.** Goshen.

Analysis.

SiO ₂	40.06
Al ₂ O ₃	30.67
Fe ₂ O ₃	2.45
CaO	23.91
MgO	.49
H ₂ O	2.25
	99.83
Sp. gr	3.341

C. Rammelsberg: Pogg. Ann., C., p. 133.

1876. **Zoisite.** Pelham.

Small, thin, nearly transparent, colorless crystals, much resembling euclase in form; also in columnar aggregations; both varieties embedded in crystals of black tourmalinite. H. 6.5; sp. gr. 3.3; before the blowpipe like zoisite.

SiO ₂	42.20
CaO	22.00
Fe ₂ O	7.10
MgO	2.08

C. U. Shepard: Contrib. to Min. (priv. pub.), p. 4.

1880. **Zoisite.** Williamsburg.

There is a magnificent zoisite in the Smith College collection; an eight-sided gray prism $1\frac{1}{4}$ inches in diameter, 2 inches long, with feldspar in center, and associated with chlorite.

1881. **Zoisite.** Williamsburg.

WILLIAMSBURG, *January 27, 1881.*

DEAR SIR: Yours received this day. Plumose mica abounds on what is known here as Gear Hill, about 1 mile northwest, near the hamlet called Searsville. I have found it plentiful there for some sixty years, and have supposed it the best locality known. Found only within the circuit of a few hundred acres.

Epidote or zoisite last procured by me was found 4 miles hence on the Ashfield road, upon land owned by Andrew I. Hitchcock. A large boulder full of it, associated with hornblende schist, has been thoroughly broken up, mostly carried away, I think. I have not explored for it much in this region. I merely have a Yankee guess it may be found near by there.

Many years since I have found it in various places in Goshen; also found it in Worthington; a few most beautiful crystals. Now I should not know where to find it in this town of Worthington.

You can find a large mass of it on land of Elisha Mason, some 3 miles west of the East Village in Cummington. Mr. Robbins, in East Village, or A. C. Chapin, in the West Village, are excellent guides or directors.

In the same range we find it in Colerain, and in Halifax, Vt. In Colerain, near Heath line, on land near Anson Dwight, who knows the place. I have a hundred-pound mass of it rolled up on a bank for someone's use.

Yours, truly,

MORRIS DWIGHT.

1882. **Zoisite.** Pelham asbestos mine.

Embedded in massive tourmaline; sp.gr. 3 to 3.2; H. 7.5; before the blowpipe fusible to blebby green glass.

Analysis.

SiO ₂	41.27
Al ₂ O ₃	12.20
Fe ₂ O ₃	9.82
CaO	23.20
MgO	2.08

Analysis unpublished.

C. U. Shepard, 1875.

(In small, elongate crystals 1 inch in length, of yellowish color, and in colorless masses with radiate columnar structure. In the last opening of the mine the mineral was found in highly lustrous, transparent prisms a half inch across, colorless and completely fresh. It was embedded in black biotite.)

1887. **Zoisite.** Shelburne Falls.

From large boulders in a well; large, foliated masses of the finest light-pearl gray; stout prisms; not terminated, and smaller blades interlaced with quartz to form a rock.

In collection of Amherst College.

1890. **Zoisite.** Shelburne.

Three-quarters of a mile northeast of Center, south of Charles Smith's place.

Large boulders north of road to Center. Many terminated crystals, very simple and untwinned; gray, changing to transparent hyacinth red at termination.

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[Bulletin No. 128.]

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WASHINGTON, D. C.

WASHINGTON, D. C., May, 1895.

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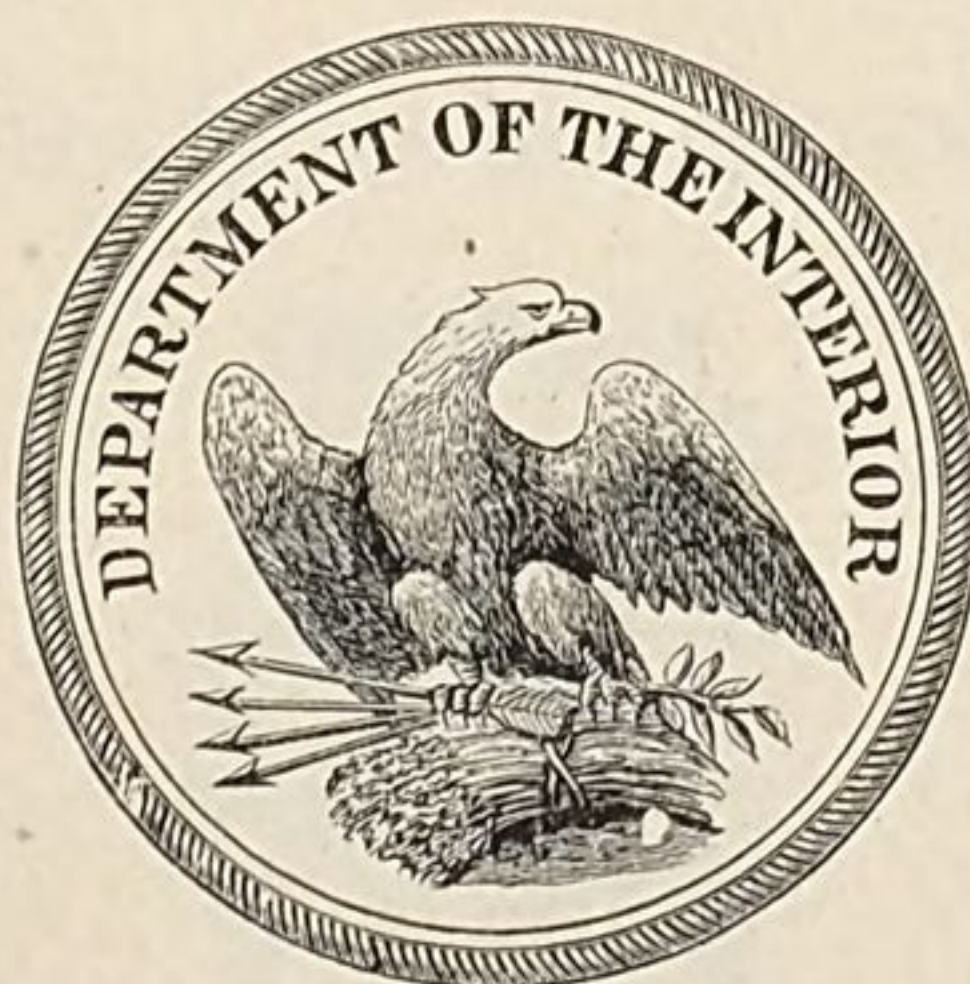
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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

THE
BEAR RIVER FORMATION

AND

ITS CHARACTERISTIC FAUNA

BY

CHARLES A. WHITE



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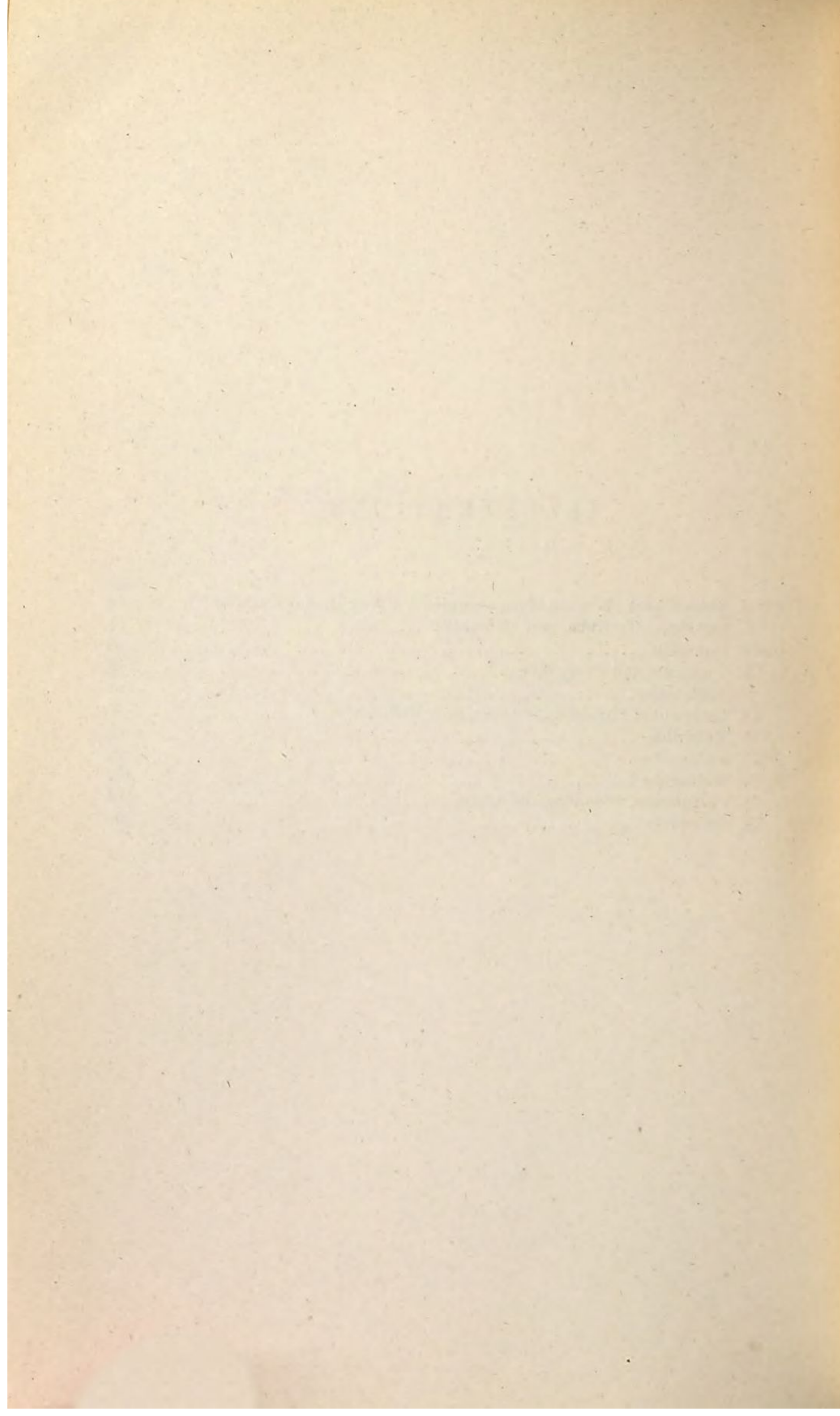
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LETTER OF TRANSMITTAL.

WASHINGTON, D. C., *March 20, 1895.*

SIR: I have the honor to transmit herewith the manuscript and illustrations of a paper on the Bear River formation and its characteristic fauna.

Very respectfully,

C. A. WHITE.

Hon. CHARLES D. WALCOTT,

Director of the United States Geological Survey.

LETTER OF THE CHURCH

TO THE MEMBERS OF THE CHURCH
AND TO ALL WHO ARE INTERESTED IN THE
WELFARE OF THE CHURCH AND THE
WORLD
BY THE
REVEREND FATHERS OF THE
GENERAL COUNCIL OF THE
CHURCH OF ENGLAND
AND OF THE
CHURCH OF IRELAND
IN THE
YEAR OF OUR LORD 1547

OUTLINE OF THIS PAPER.

The object of this bulletin is the correction of an essential error which has long prevailed among geologists concerning the taxonomic position of one of the North American Cretaceous formations; that is, its object is to present a summary of the facts which show the entire separateness from the Laramie formation of that series of nonmarine strata which has heretofore been known as the Bear River Laramie, with which formation the Bear River series of strata has long been confounded. To this end the Bear River series is defined as a distinct formation, stratigraphically, geographically, and paleontologically, and its taxonomic position is stated in detail.

The subject is discussed historically, and with reference to the published results of the work of all the geologists who have written upon it. The work of correcting the error referred to and of properly characterizing the Bear River formation, having been accomplished upon a paleontological basis, all the known fossils of this formation are herein described and figured. Comparisons are also made of its fauna with those of other nonmarine formations of this and other continents, and relevant biological questions are discussed.

THE BEAR RIVER FORMATION AND ITS CHARACTERISTIC FAUNA.

BY CHARLES A. WHITE.

HISTORICAL STATEMENT.

When we consider the geographical extent of that great interior region of North America which has been traversed and reported upon by geologists during the past forty years, the difficulty with which former explorations and investigations were attended, the complex displacements which the strata of great areas in that region have suffered, and the newness of the geological problems which the early investigators encountered there, it is not strange that errors concerning the taxonomy of formations should occasionally have been made. Such errors have, however, been remarkably few, and most of these are justly excusable for the reasons just indicated.

One of the most important errors of the kind referred to is that which relates to the Bear River formation, the position of which, with relation to its associated formations, as has lately been shown, has been erroneously stated, or conceded without question, by every geologist who examined it during a period of twenty years immediately following its discovery. After that time some doubt was entertained as to the correctness of the currently accepted views of its relative position, the most definite of which were those published by myself and presently to be mentioned; but a detailed statement of what now appears to be a correct solution of the problem was first published by Mr. T. W. Stanton in 1892.¹

Because of the former general acceptance of the error referred to, it became incorporated with American geological literature, and was consequently accepted by the geologists of other parts of the world who have had occasion to discuss formations whose fossil faunas more or less completely resemble those of the Laramie and Bear River formations.

It being the principal object of this bulletin to state further what is now regarded as the true taxonomic position of the Bear River formation, and to publish descriptions and figures of all the known fossil

¹ Am. Jour. Sci., 3d ser., Vol. XLIII, pp. 98-115.

forms which characterize it, the following historical account of the growth and prevalence of opinion concerning it is essential to a proper understanding of the subject.

In the year 1859 Mr. Henry Engelmann, geologist to the United States exploring expedition in charge of Captain Simpson, discovered a series of strata constituting an important section at a locality in southwestern Wyoming, upon the bank, and near the mouth, of Sulphur Creek, a tributary of Bear River. All except one of the members of this section, exclusive of the greatly unconformable overlying Tertiary strata which occur in the same neighborhood, were recognized as of marine origin, and at least one of these was found to be coal-bearing. The non-marine member of this section was found to contain abundant remains of a molluscan fauna which was quite distinct from any then known in North America. The fact was recognized, however, that this fauna contains specific forms which are similar to certain members of the fauna of the Lignite formation occurring in the French Department of the Mouths of the Rhone, which fauna Matheron had a few years previously published and referred to the Tertiary.

During the fifteen years following the year of their discovery those nonmarine strata in southwestern Wyoming were generally spoken of by geologists as the Bear River estuary beds, because it was generally believed that they were of estuarine origin. Later explorations, however, have revealed their presence at other localities in Wyoming, and at still others in the adjoining part of Idaho, which are so widely separated from one another as to show that the formation has greater geographical extent than may reasonably be expected of a true estuarine deposit. Furthermore, no known fact, other than the evident brackish-water character of the branchiferous members of its fauna, is suggestive of its estuarine origin.

During the time mentioned, also, no one seems to have expressed any doubt of the Tertiary age of these strata, because their fossil fauna, although consisting of species which were then new to science, included types which were at that time regarded by all geologists as characteristic of the Tertiary. This view was supposed to be supported by the stratigraphical relation of these strata to the other members of the same section. That is, they were believed to constitute the latest member of the section in which they were found to occur, and to overlie unmistakably Cretaceous strata; but these facts will be more fully stated further on.

About the year 1876 those nonmarine strata which had been discovered at various and widely separated localities in the great interior region, and which are now properly referred to the Laramie, began to be generally recognized as constituting one great formation, and the nonmarine strata of the Bear River Valley district, herein specially referred to, came to be generally known as the Bear River Laramie. This name was applied to those strata because they were thought to

have been contemporaneous in origin with the true Laramie, and to hold the same taxonomic position with relation to other formations, although it was well known that their molluscan fauna is very different from that of the Laramie.

Soon after the recognition of the integrity of the great Laramie formation throughout a great geographical area, and the discovery in its strata of Mesozoic as well as Cenozoic types of fossils, differences of opinion arose among geologists as to whether it is properly assignable to the Tertiary or to the Cretaceous. These differences of opinion had reference also to the Bear River formation, because it was then believed to be a part of the Laramie, but the question thus raised was one of geological age only, and did not extend to the subject of the relation of the Bear River strata to other members of the section in which they were then known to occur.

The first published account of the Bear River strata was given by Messrs. F. B. Meek and Henry Engelmann, jointly, in 1860;¹ and later in the same year Mr. Meek published descriptions of some of the fossils which characterize them.² In these publications both authors unhesitatingly assigned the strata in question to the Eocene Tertiary.

No other publication concerning them seems to have appeared until 1869, when Dr. F. V. Hayden inserted a paragraph containing a reference to them in one of his official reports upon another region.³ In this paragraph he expressed the opinion that they are of Tertiary age, and proposed to include in one and the same group the coal-bearing strata of the Sulphur Creek section, those near Evanston, and those at Coalville, Utah, giving that incongruous assemblage the name Bear River group.⁴

In 1870 Dr. Hayden published a short article containing a minute description, accompanied by figures, of the nonmarine strata originally discovered by Mr. Engelmann, now called the Bear River formation, in which publication he continued to assign them to the Tertiary.⁵

In the same volume, and immediately following the article of Dr. Hayden's just mentioned, Mr. Meek catalogued and described a number of new species of fossils, among which are some that were obtained from the Bear River formation at and near the first discovered locality. These Mr. Meek assigned to the Tertiary without comment or qualification.

In his official report for 1870, Dr. Hayden republished the substance of his article in the Proceedings of the American Philosophical Society, just referred to, in which he again assigned the Bear River formation to the Tertiary, stating its position to be at the top of the Sulphur

¹ Proc. Acad. Nat. Sci. Phila., Vol. XII, pp. 126-131.

² Ibid., pp. 308-315.

³ Prelim. Rept. U. S. Geol. Surv. Colorado and New Mexico, p. 91.

⁴ The Bear River group, as proposed by Dr. Hayden, embraced strata now known to belong to three separate formations; I retain the name for those only which pertain to one of them; that is, for those to which the name "Bear River" has been most generally applied.

⁵ Proc. Am. Philos. Soc., Vol. XI, pp. 420-425, pl. xii.

Creek section. This volume of reports contains also a chapter by Mr. Meek¹ concerning the fossils which were collected from various formations by Dr. Hayden during the previous year, in which he assigned to the Tertiary all the species that were obtained from the Bear River formation.

In Dr. Hayden's official report for 1871 Mr. Meek again catalogued the fossils from the Bear River formation under the head of Tertiary;² and in the same year Mr. T. A. Conrad referred this formation to the Lower Eocene. He seems to have done this solely because of the type-character of its fauna,³ as he had never visited the region in which it occurs.

In 1872 Mr. Meek, in company with Dr. H. M. Bannister, visited Bear River Valley, and specially studied the section which is exposed along Sulphur Creek, near its mouth, and which, as before mentioned, includes, besides a great thickness of marine strata, those of non-marine origin which have just been mentioned as having been first discovered by Mr. Engelmann. The results of this study were published by Mr. Meek in 1873,⁴ in connection with which publication he gave a figure of the section referred to, accompanied by a detailed description of its members. In this publication he continued to catalogue the fossils of the Bear River formation under the head of Tertiary, but in his remarks upon these strata he for the first time expressed some doubt upon this point, and suggested that they might "belong to the Upper Cretaceous." It is evident, however, that he was still of the opinion that their position is at the summit of the Sulphur Creek section, and, therefore, above all the undisputed Cretaceous strata which constitute its other members.

The character of his discussions concerning the paleontology of the Bear River formation in this and in previous publications shows that the doubt referred to was not entertained on account of any evidence afforded by the fossils obtained from those strata, all of which he regarded as of Tertiary types, but he seems to have been influenced by the fact that dinosaurian remains had then for the first time been discovered in strata, now known to belong to the Laramie formation proper, which until then had been by all geologists regarded as of Tertiary age, as also had been the Bear River formation.

Upon the geological sheet of the general atlas of the United States Geological Exploration of the Fortieth Parallel, which shows the district traversed by Bear River, the strata which are now known to be properly referable to the Bear River formation are indicated as belonging to the Laramie, and the areas which they occupy are colored upon that sheet in the same manner as are the true Laramie areas. This atlas was published in 1876, and the geology of the Bear River district

¹ Fourth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., pp. 149-153.

² Fifth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 376.

³ Am. Jour. Sci., 3d ser., Vol. I, pp. 381-383.

⁴ Sixth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., pp. 451-454.

represented by it is understood to be the joint work of Messrs. Clarence King and S. F. Emmons.

In his final report, also, Mr. King assigned the Bear River strata in question to the Laramie;¹ and he correlated those of the originally discovered locality, near the mouth of Sulphur Creek, with the uppermost beds of the true Laramie at Black Buttes. Mr. Emmons, also, in his final report, assigned the same strata to the Laramie.²

At this time the belief already mentioned had become general; that is, that the Bear River formation, notwithstanding the material difference of its fossil fauna from that of the great formation which then began to be known by the name of Laramie, was contemporaneous with the latter, and that both hold the same relation to overlying and underlying formations. For these and other reasons the Bear River formation began, as already stated, to be known as the Bear River Laramie, the evident object of that special designation being only to indicate a recognition of the faunal difference between it and the great Laramie formation.

The final report of Mr. Engelmann was not published until 1876,³ sixteen years after he had submitted it to Captain Simpson, and the same length of time after he had published his original report. At the time of the later publication discussion as to the true geological age of the Laramie formation, including the Bear River strata, had become somewhat prevalent, some contending for their Tertiary and some for their Cretaceous age. Apparently influenced by these discussions, Mr. Engelmann, in revising his final report, expressed the belief that the Bear River strata are of Cretaceous age, although in his original article, published jointly with Mr. Meek (*loc. cit.*), the opinion that they are of Tertiary age is plainly stated, and in the later publication he cites no new fact that might have caused a change of opinion.

Mr. Meek's final report to Captain Simpson on the fossils of the Bear River formation is contained in the same volume with that of Mr. Engelmann (*op. cit.*), and in his discussion of them he too was disposed to assign them to the Cretaceous, but he nowhere indicates a belief that the taxonomic position of the Bear River formation is not the same as that of the true Laramie. In his last published writing⁴ he expressed the same opinion which he had formerly held, namely, that the Bear River strata are equivalent to the Laramie. In this last work of his he also described and figured several of the characteristic species of the Bear River formation.

It was in 1876, also, that Maj. J. W. Powell, who had in the previous year personally examined the geology of the district embracing the lower portion of Sulphur Creek Valley and the adjacent portion of Bear

¹ U. S. Geol. Explor. Fortieth Par., Vol. I, p. 373 and map iii, 1878.

² *Ibid.*, Vol. II, p. 327, 1877.

³ See Simpson's Report on the Great Basin of Utah, pp. 247-336, 1876.

⁴ U. S. Geol. Explor. Fortieth Par., Vol. IV, p. 163, 1877.

River Valley, published his views of the Bear River formation.¹ He accepted the conclusions which Mr. Meek had reached concerning the order of superposition of the members of the Sulphur Creek section, and published a verbatim copy of Meek's description of it. In this publication Major Powell treated the Bear River strata as equivalent to his Point of Rocks group, which is equivalent to the Laramie, both of which he assigned to the Cretaceous; but he placed the Bear River strata at the summit of the Sulphur Creek section, as all the other geologists had previously done. In the same volume I described several of the characteristic molluscan species of the Bear River formation.²

In certain of my writings which were published in 1877 and 1878 I assigned the strata which I now designate as the Bear River formation, as well as the coal-bearing beds near Evanston, which are also found in Bear River Valley, to the great Laramie formation.³ Both of these assignments, however, having been erroneous, a part of the conclusions which were reached in their discussion were necessarily erroneous also.

The results of some extended field observations made by myself in Colorado, Utah, and Wyoming were published in 1879.⁴ In the part of that publication which relates to the geology of Bear River Valley I expressed the views which I then held concerning the relation to the Laramie formation of the Bear River strata and of the Evanston coal-bearing beds. These views were similar to those expressed in my publications of the two previous years, except that in the later publication I suggested that the Bear River strata are probably older than the Laramie; but I based this opinion upon the fact that the characteristic types of the Bear River fauna are much less like those of any Tertiary, or now living North American, fauna than are those of the Laramie. In 1883⁵ I repeated the expression of this opinion as to the greater age of the Bear River strata, but my views were not in either case fully stated.

In 1879 Dr. A. C. Peale twice published results of his examination of the geology of a portion of western Wyoming,⁶ in which publications he showed that the Bear River formation has a greater geographical extent than was before known. He found these strata occupying a belt of country of varying width, lying partly in Wyoming and partly in Idaho, and extending northward from the place of their original discovery to the forty-third parallel of north latitude, a distance of about 100 miles. Besides this, he reported the existence of a narrower and shorter belt lying parallel with the other a few miles farther eastward.

Most of the strata throughout the district examined by Dr. Peale, as well as those of the first discovered locality, have been much displaced by orogenic movements, in consequence of which the structural

¹ Geology of the Uinta Mountains, p. 158.

² Ibid., pp. 118, 122, 123.

³ Bull. U. S. Geol. and Geog. Surv. Terr., Vol. III, pp. 607-614. Idem, Vol. IV, pp. 707-724.

⁴ Eleventh Ann. Rept. U. S. Geol. and Geog. Surv. Terr., pp. 161-172.

⁵ Third Ann. Rept. U. S. Geol. Surv., p. 430.

⁶ Eleventh Ann. Rept. U. S. Geol. and Geog. Surv. Terr., pp. 511-644; and map accompanying the Twelfth Ann. Rept. Also, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. V, pp. 195-200.

geology there is often found to be obscure. Doubtless because of this obscurity he failed to see any reason to oppose the then prevalent opinion that the Bear River formation is referable to the Laramie epoch, and reported that formation as overlying a series of strata which he assigned to the Cretaceous, but he admitted that he found no paleontological evidence of their Cretaceous age.

In 1877 and 1878 Prof. Orestes St. John examined the geology of a portion of western Wyoming and the adjacent part of Idaho, his district lying immediately north of the one examined by Dr. Peale, but the results of his work were not published until 1882.¹ In this report he shows that the Bear River strata, which, following the then prevalent custom, he assigned to the Laramie, occupy considerable areas in the district examined by him, one of them being a northward continuation of the principal belt reported on by Dr. Peale. These areas show a northward continuation of the Bear River formation of about 40 miles more than was shown by the results of Dr. Peale's observations, and they seem to mark the extreme northern limit of the formation.

The structural geology of Professor St. John's district is even more obscure than is that of Dr. Peale's, but he seems to have had little difficulty in recognizing the separate identity of the formations which exist there. The difficulty of determining their taxonomy, however, was increased over that of other portions of the Bear River district by the apparent absence of any marine Cretaceous strata associated with the Bear River strata which he found there.

From 1881 to 1885, inclusive, I published several articles in which reference is made to certain of the characteristic fossils of the Bear River formation.² In all of those publications, with the partial exception of my review of the nonmarine fossil mollusca, already mentioned, the fossils of that formation are so referred to as to convey the idea of its equivalency to the Laramie.

During the preparation of my review of the North American Cretaceous formations, which was published in 1891,³ I found it necessary to discuss the Laramie formation in that connection. While reviewing the literature and paleontology of that portion of my subject and con-

¹ Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., Part I, pp. 175-269 and map.

² The following statement of the titles and places of publication of these articles, in addition to similar references in preceding footnotes, is given for the purpose of making bibliographical reference to the subject of this bulletin as complete as practicable:

Tanganyika shells. *Nature*, Vol. XXV, pp. 101, 102.

On certain conditions attending the geological descent of some North American types of fresh-water gill-bearing mollusks. *Am. Jour. Sci.*, Vol. XXIII, pp. 382-385.

New molluscan forms from the Laramie and Green River groups, with discussion of some associated forms hitherto known. *Proc. U. S. National Museum*, Vol. V, pp. 94-99, pls. 3 and 4.

A review of the nonmarine fossil mollusca of North America. *Third Ann. Rept. U. S. Geol. Surv.*, pp. 411-550, pls. 1-32.

Contributions to invertebrate paleontology, No. 4; Fossils of the Laramie group. *Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr.*, Part I, pp. 49-103, pls. 20-30.

The genus *Pyrgulifera* Meek and its associates and congeners. *Am. Jour. Sci.*, Vol. XXIX, pp. 277-280.

³ *Bull. U. S. Geol. Surv.* No. 82.

sidering the statements there made in connection with the results of my personal visits to Bear River Valley, I became more than ever convinced that the Bear River formation is older than the Laramie, and that it would somewhere be found overlain by Cretaceous strata. This opinion I expressed on page 153 of the work referred to.

THE TAXONOMIC POSITION OF THE BEAR RIVER FORMATION.

The considerations mentioned in the last one of the preceding paragraphs seemed to demand an immediate and determined attempt to solve the question of the relative position of the Bear River strata. Therefore, in the field season of 1891 Mr. Stanton accompanied me to the Bear River Valley, and together we reviewed its geology up to the point where my previous investigations had ceased. It being then impracticable for me to continue field work, I left him to pursue the investigations alone, the results of which he embodied in the article already referred to,¹ and his principal conclusions are also stated on the following pages. This article was accompanied by one prepared by myself, which contained a statement of the principal facts mentioned on the preceding pages.²

The results of Mr. Stanton's investigations show that the Bear River formation, instead of occupying a position at the top of the North American Upper Cretaceous series, as it was formerly supposed to do, and as does the Laramie formation, lies beneath the greater part, if not the whole, of that series. That is, he has determined its position as beneath the Colorado formation and above that series of Jurassic strata which occurs within a large part of the interior region of North America and which are generally regarded as of Upper Jurassic age. The following table, copied from Mr. Stanton's article before referred to, represents the section as determined by him in the Bear River district. It shows not only the position of each of its members with relation to one another, but also their relation to the complete Upper Cretaceous section of the great Rocky Mountain region:

¹ Am. Jour. Sci., Vol. XLIII, pp. 98-115, February, 1892.

² Ibid., pp. 91-97.

Mr. Stanton's Bear River general section.

Tertiary.	Wasatch.	Conglomerates, coarse sandstones, and shales, with coal at the base.
Cretaceous.	Laramie.	Wanting, or included in the above.
	Montana.	Not positively identified.
	Colorado.	Shales and coal-bearing sandstones. Thickness not less than 2,500 feet.
	Bear River.	Very fossiliferous, argillaceous, and calcareous shale, alternating with thin beds of sandstone.
	Dakota?	Conglomerates and coarse sandstones. Thickness of last two 2,500 to 4,000 feet.
Jurassic.	Belemnites beds.	Thin-bedded sandstones and sandy shales.

The following table shows the equivalency of the members of Meek and Hayden's Upper Missouri Cretaceous section with those which are now generally recognized as constituting the Upper Cretaceous series as it occurs in the great Rocky Mountain region and in the Green River basin, in Wyoming. The names of these members are mentioned in the foregoing table by Mr. Stanton, but the comparison is made in the following table for the convenience of those who are more familiar with the older than with the later names:

Nomenclature of Upper Cretaceous series.

<i>Meek and Hayden's Upper Missouri section.</i>	<i>Upper Cretaceous section of Rocky Mountain region, etc.</i>
Judith River beds (Laramie).	Laramie.
Fox Hills group. Fort Pierre group.	Montana.
Niobrara group. Fort Benton group.	Colorado.
Dakota group.	Dakota.
Jurassic.	Jurassic.

Notwithstanding the evident accuracy of Mr. Stanton's determinations as to the relative position of each of the members of the Bear River section, there are still some unsolved questions relating to the exact taxonomic position of the Bear River formation proper and of the unfossiliferous conglomerates and sandstones which underlie it and overlie the Belemnite-bearing Jurassic beds; that is, the following questions may justly be propounded: Is the Bear River formation of later, contemporaneous, or earlier origin than the Dakota formation? If of earlier origin, is it of Upper Cretaceous, Lower Cretaceous, or Jurassic age? Are the conglomerates and sandstones just mentioned of Jurassic age; are they referable to the Dakota formation, or do they represent some formation of intervening age? Discussions of these questions must, of course, have reference to both stratigraphy and paleontology.

Unfortunately, stratigraphical indications upon the subject are confined to the order of superposition of the members of the Bear River section as it has been determined by Mr. Stanton, because all of them, including the unquestioned Jurassic, are apparently strictly conformable with one another, and there is therefore no physical indication of a time hiatus between any of them.

The apparently strict conformity of the conglomerates and sandstones with the Belemnite-bearing, and therefore marine, Jurassic strata, which they overlie, offers at least a suggestion that the former may represent the nonmarine upper division; that is, the "Atlantosaurus beds" of the Jurassic as it is developed in Colorado and Wyoming. This fact as to conformity, however, offers little or no more than a suggestion, because the Dakota formation is equally conformable with the Jurassic wherever contact between them has been observed. Therefore all known indications are quite as much in favor of Mr. Stanton's suggestion of the Dakota age of those sandstones and conglomerates as they are of their Jurassic age. His opinion that they are probably equivalent to the Dakota, also accords with that of the members of the Fortieth Parallel Survey. No direct paleontological aid is available for the solution of this question, because those conglomerates and sandstones have not yet furnished any fossils.

While the Bear River formation is an abundantly fossiliferous one, paleontological indications of its geological age are indefinite for several reasons, among which are the following: No other fossils have been found in it than those which are described and figured in this bulletin, except some imprints of angiospermous leaves, which, although identifiable as such, are too fragmentary for satisfactory illustration. No vertebrate fossils are known to exist in any of its strata, although some scattered cycloid fish scales have been found in immediately overlying shales. Its invertebrate fauna, as a whole, is very different from any other known North American fauna, and, besides this, such of its faunal types as are like those which occur in other North American strata have had a long geological time range. For example, Jurassic

nonmarine molluscan remains have been discovered in Colorado and Wyoming¹ which belong to types quite as modern in character as are any of those of the Bear River fauna, and not an inconsiderable part of the types of both the faunas referred to are found among now living mollusca. Therefore, so far as the Bear River fauna is now known, and when it is considered with reference to other North American faunas, it seems to afford very little, if any, intrinsic paleontological evidence as to whether it is of Cretaceous or Jurassic age.

At two localities, however, Mr. Stanton found the few fragmentary imprints of angiospermous leaves just referred to, which, although too imperfect for specific designation, are plainly of the general character of such plant remains as are common in Upper Cretaceous strata, and they are unlike any that are known in either the Lower Cretaceous or the Jurassic strata of North America. This, so far as it goes, may be regarded as an intrinsic paleontological indication of the Upper Cretaceous age of the Bear River formation, and allies it with the Colorado and Montana formations. Furthermore, it is shown on following pages that several of the molluscan members of the Bear River fauna are so closely similar to forms which occur in the Colorado formation as to suggest their specific identity. This still further indicates the affinity of the Bear River formation with the overlying members of the Upper Cretaceous series.

On the other hand, wherever the Dakota and Colorado formations have been found in contact, their strata are not only conformable, but in certain districts their paleontological relation² to each other has been found to be quite as intimate as is that of the Bear River formation with the Colorado, which has just been mentioned. Such conditions seem to preclude the probability of the existence of an intermediate series of strata in either case.

This apparent intimacy of relationship of the Colorado formation with both the Dakota and Bear River is suggestive of the contemporaneity of origin of the two latter formations; but we are here met with the fact that the faunal characteristics of the two formations are very different from each other,³ although both are of nonmarine origin. Therefore, to assume the contemporaneity of origin of the Bear River and Dakota formations is to assume that their discordant aquatic faunas were developed independently and in separate hydrographic basins. This is not improbable, but we have yet no proof of it.

On the other hand, there seems to be no discovered direct proof that the nonmarine Bear River strata do not represent the early part of the Colorado epoch, which is represented by marine strata only in those

¹See Bull. U. S. Geol. Surv. No. 29, 1886.

²So far as the Dakota formation is concerned, it is the marine portion only that is here referred to, such, for example, as those found in Kansas and Texas. For remarks upon these marine Dakota strata and their fossils see Proc. U. S. Nat. Museum, Vol. XVII, pp. 136-138, 1894.

³It is true that a species of *Pyrgulifera* has lately been discovered in Dakota strata, as will be more fully mentioned on a following page, but it is the difference between the Dakota and Bear River faunas, each as a whole, that is here referred to.

districts where the Dakota formation is distinctly recognizable at its base. An indirect suggestion that the Bear River formation is separate from the Colorado is, however, furnished by the section in Weber Valley, about 30 miles southwestward from the Sulphur Creek section. The Jurassic is distinctly represented in Weber Valley, and the Colorado formation is there apparently complete, even to its base. Between these two formations there are two series of strata, in neither of which have any fossils been found. The lower one of these formations Mr. Stanton regards as equivalent to the conglomerates and sandstones of his Bear River general section, as shown on page 21, and as possibly equivalent to the Dakota formation. The upper one he thinks is probably equivalent to the Bear River formation.¹ If these suggestions shall prove to be correct, they will indicate that the deposition of the Bear River formation was already completed at the beginning of the Colorado epoch, and the fact will also indicate a greater southern extension of the Bear River formation than is now certainly known.

The questions propounded on page 22 are therefore still unanswered or answered only in part; but in view of the facts which I have stated and of Mr. Stanton's determinations, I do not now hesitate to assign the Bear River formation to the Upper Cretaceous, and to designate its position as at or near the base of that series. This assignment also accords with the reputed age of a formation in Hungary² whose fauna is more nearly like that of the Bear River formation than any other known.

PROBABLE CAUSES OF FORMER ERRORS CONCERNING TAXONOMIC POSITION, ETC.

Because the views concerning the position of the Bear River formation with relation to other formations which have been controverted upon the preceding pages have been held by so large a number of observers, including some of the ablest of North American geologists, it is proper to offer some explanatory, if not apologetic, suggestions as to the causes of the origin and long continuance of those erroneous views. These causes evidently relate in part to the great disturbance which the Bear River strata have suffered and to other physical conditions, and in part to erroneous preconceived paleontological opinions.

For a long time after the discovery by Mr. Engelmann of the section of strata near the mouth of Sulphur Creek, strata equivalent to those of that part of it which is now known as the Bear River formation were not known to occur elsewhere, and it was upon the examination of this section only that the views referred to were originally formed. All the strata of the Sulphur Creek section are greatly disturbed, a large part

¹Bull. U. S. Geol. Surv. No. 106, p. 46, 1893.

²See Tausch (Leopold von). Ueber die Fauna der nicht-marinen Ablagerungen der oberen Kreide des Csingerthales bei Ajka im Bakony, Ungarn. Abhandl. K.-k. geol. Reichsanstalt, Band XII, No. 1, Wien, 1886.

See also Oppenheim (Paul). Ueber einige Brackwasser- und Binnen-Mollusken aus der Kreide und dem Eocän Ungarns. Zeitschr. Deutsch. geol. Gesell., Band XLIV, Heft 4, Berlin, 1892.

of them standing vertical or nearly so, and others are inclined at various angles. Besides this, they are now known to be traversed by faults which are so much obscured that their character or even their existence was hardly demonstrable before the facts brought out by Mr. Stanton were applied to the study of the strata of that district. Furthermore, the Sulphur Creek section is exposed only within a small neighborhood, where it is closely surrounded by a broad expanse of unconformably overlying Tertiary strata. These Tertiary strata so completely cover the strata which are or originally were continuous with those of the section as to make it impracticable to trace any of the latter continuously more than a short distance.

It is only in the district which extends northward from Sulphur Creek that any other than the original discoveries of Bear River strata have been certainly made. When this district began to be examined the work was necessarily done in a desultory manner, because the geologists who did the work were attached to topographical surveying parties, to whose movements theirs were subordinated. The difficulties of travel were also great, because pack and riding animals were the only means for conveying persons and for transporting supplies. In addition to the disadvantages just mentioned, these geologists were necessarily influenced in their judgment by the published views of those who had previously reported upon the Sulphur Creek section. They found the Bear River and associated formations everywhere nearly or quite as much disturbed as they are at the Sulphur Creek locality, and in their necessarily hasty examinations they did not discover the error that had been made there.

Besides the difficulties imposed by the conditions just mentioned, one of the most important elements in the solution of the question involved seems to be entirely absent from the whole district in which the Bear River formation occurs. That is, the reports which have been made by various geologists upon western Wyoming and adjoining parts of Utah and Idaho indicate that no true Laramie strata exist in any part of the district where those of the Bear River formation occur. Therefore, those observers were all the more ready to accept the Bear River strata as representing the Laramie. Further confusion was caused by erroneous identification of some of the marine Cretaceous strata of the Sulphur Creek section. That is, in the region surrounding the Bear River district the molluscan faunas of the equivalents of the Colorado and Montana formations, respectively, present so many differences from those faunas as they are known farther eastward that the strata of the Sulphur Creek section which are now known to belong to the Colorado formation were believed to belong to the later Montana formation.

Although the greatly disturbed and obscured condition in which the strata of the Bear River and its associated formations were found was the primary cause of the erroneous conclusion as to their order of super-

position which was reached by the geologists who first investigated them, it can not be denied that the then prevalent paleontological views are largely responsible for it. That is, none of these investigators seem to have doubted that such types as those which are included in the Bear River fauna are characteristic of, and peculiar to, the Tertiary. The fact also that the Bear River strata are of nonmarine origin evidently had some influence in favor of assigning them to the Tertiary, because at that time little was known of the existence in North America of nonmarine strata earlier than those of Tertiary age. Moreover, they found the Bear River strata occupying a position at one end of the exposure of a series of strata which contain unquestionable marine Cretaceous fossils,¹ and believing these nonmarine strata to be of Tertiary age, they necessarily assumed that they overlie their associates of marine origin.

In the light of all the facts now known, it seems strange that the wide difference between the fauna of the Bear River strata and that of the Laramie did not cause more distrust of the idea which was then entertained that they were of contemporaneous origin, especially because it was this discordance of faunal characteristics which finally suggested to me the investigations that have resulted in assigning the Bear River formation to a much earlier epoch than that of the Laramie.² Still, the full extent of the faunal difference referred to was not known to the first investigators of those formations, and the difference which was then known to exist was, they thought, probably due to the division of the waters of the Laramie epoch either into different faunal areas or into different hydrographic basins. It is also just to add that while the principal error which has been discussed on the preceding pages was largely due to erroneous paleontological views, it is equally true that without the aid of paleontology that error could not have been refuted.

Finally, in putting forth this explanation of what is regarded as the true taxonomic position of the Bear River formation, it is proper to say that the conclusion reached is largely based upon the knowledge of facts and principles bearing both directly and indirectly upon this subject which has accumulated since the work of the earlier investigators was accomplished. Besides this, the district occupied by the Bear River formation, which was a wilderness when they began their investigations, is now traversed by two railroads, and all parts of it are readily accessible for study.

GEOGRAPHICAL EXTENT OF THE FORMATION.

Having discussed the separate identity and stratigraphical relations of the Bear River formation, it remains to consider the geographical area which it occupies, or within which its strata are known to occur.

¹See Mr. Meek's figure of the Sulphur Creek section, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1872, p. 451. Also Mr. Stanton's reproduction of the same, Am. Jour. Sci., Vol. XLIII, p. 102, Feb., 1892.

²See Third Ann. Rept. U. S. Geol. Surv., p. 430, 1883; Eleventh Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1877, p. 247, 1879; and Bull. U. S. Geol. Surv. No. 82, p. 153, 1891.

Our knowledge of the true limits of this area has hitherto been, and to some extent still is, indefinite or uncertain for three reasons: First, those strata were not until lately fully differentiated from the Laramie; second, among the fossils which have from time to time been obtained in various districts other than that in which the Bear River fauna was originally discovered are some which so closely simulate certain Bear River species that they have been erroneously identified with them, thus giving origin to erroneous reports concerning the geographical extent of the Bear River formation; third, all the smaller, but nevertheless important, details of the geology of the great region in which the Bear River strata are now known to occur have not yet been fully worked out. The first reason has already been discussed, and it is desirable to consider the other two.

The former belief, which has just been indicated, and which was also mentioned by me in a previous publication,¹ that Bear River strata exist in certain districts of eastern and southern Utah, never resulted in the accumulation of such facts as would warrant a definite indication of the outlines of the areas in which they were supposed to occur. This belief was based upon the assumed identity of certain species of fossil shells which from time to time reached the hands of paleontologists from various persons who had visited the districts referred to. A part of these reputed identifications were wholly erroneous, as has been shown by the discovery of essential differences of structure; but in other cases, even when the essential structure of the whole shell is known, the identity is so apparently real that it is difficult or impracticable to prove it otherwise.

The cases of assumed identification which are now certainly known to be erroneous were due to reliance upon the external form of the shells examined, and those cases, concerning which there is still some doubt, were due to a want of strong specific features in the shells of all the members of the genus to which they belong. It will be sufficient for my present purpose to mention one case each of these two kinds.

A case of total error of identification is that of a gasteropod species, of which many specimens were received from different localities in Utah. These shells in outward aspect resemble typical forms of *Pyrgulifera humerosa* even more closely than do some of its unquestionable varieties, and upon this external character alone the identification was based, the interior features not having been then ascertained. Subsequently, however, these shells were found to possess folds upon the columella like those which characterize *Admetopsis*. This character, of course, not only requires their reference to another species, another genus, and another family, but it indicates a marine instead of a nonmarine origin for the fauna to which it belongs.

¹ Am. Jour. Sci., 3d ser., Vol. XLIII, p. 97, February, 1892.

A case of still questionable identification is that of a species of *Corbicula* or *Cyrena* which, although its essential details of structure are known, it is difficult to describe as different from *Corbicula durkeei*. The doubt here implied whether the shell in question is a *Corbicula* or a *Cyrena* is due to the absence or obliteration of transverse striae upon the lateral teeth of the specimens received. The discrepancy in this case was thought to have been due to obliteration, because those striae are often obliterated, and are never so conspicuous upon the shells of *Corbicula durkeei* as they usually are upon North American species of *Corbicula*.

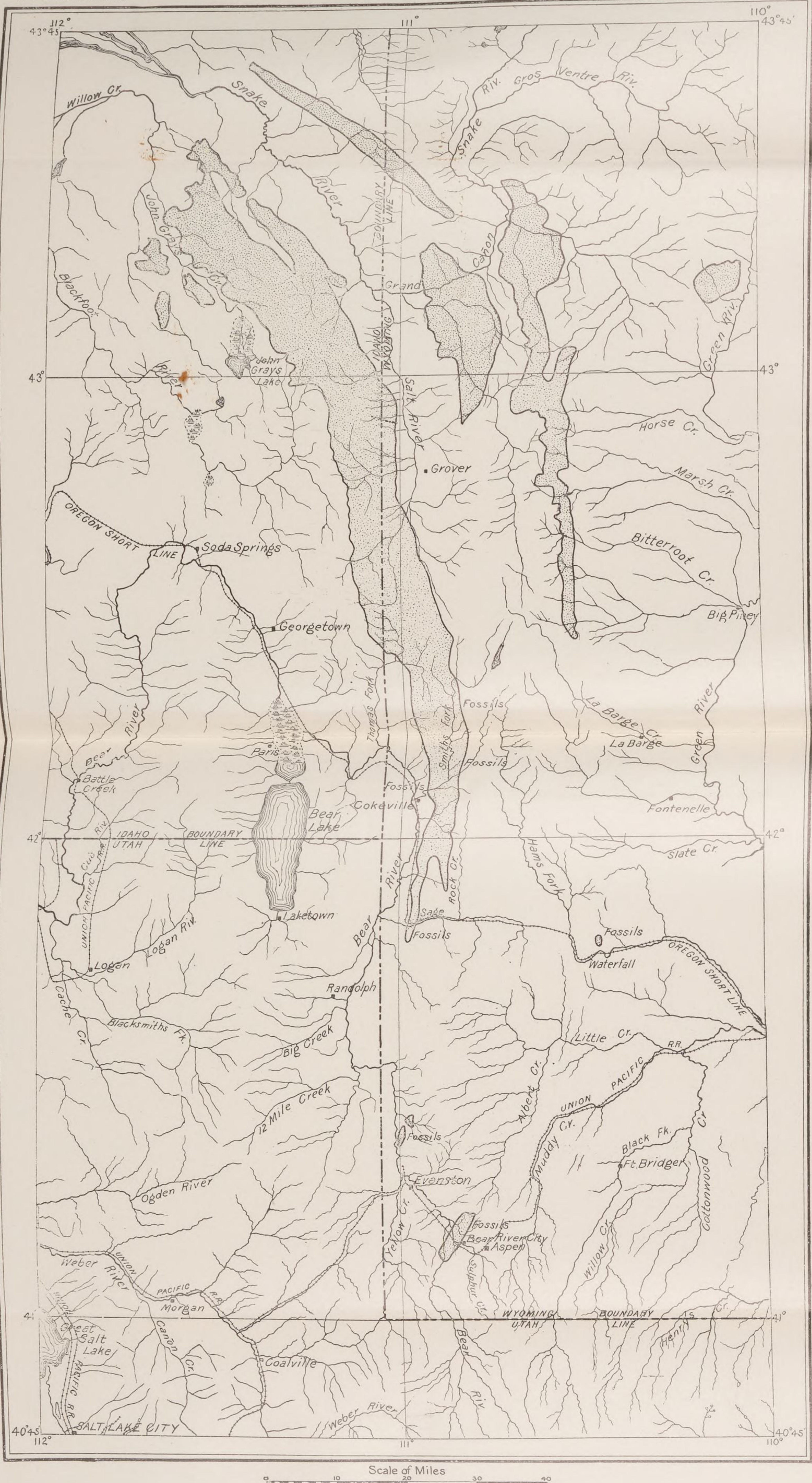
These two species, *Pyrgulifera humerosa* and *Corbicula durkeei*, are two of the most conspicuous and characteristic of the members of the Bear River fauna, and the forms just mentioned, which so closely simulate them, are now known to have been obtained from the Colorado formation and to be members of its marine fauna. Moreover, in the districts where they were found later investigations have failed to reveal the presence of any strata which contain unmistakable members of the Bear River fauna.¹

In connection with the description on following pages of the species which constitute the Bear River fauna, some suggestions are made as to the possibility that certain of them may have survived into the Colorado epoch, and that in such cases the apparent identity may be real, the Corbiculoid species just referred to being one of them. The forms in question, however, being such as present comparatively few salient specific characteristics, and also such as occur with little variation in formations of different ages, the evidence they furnish is not entirely satisfactory.

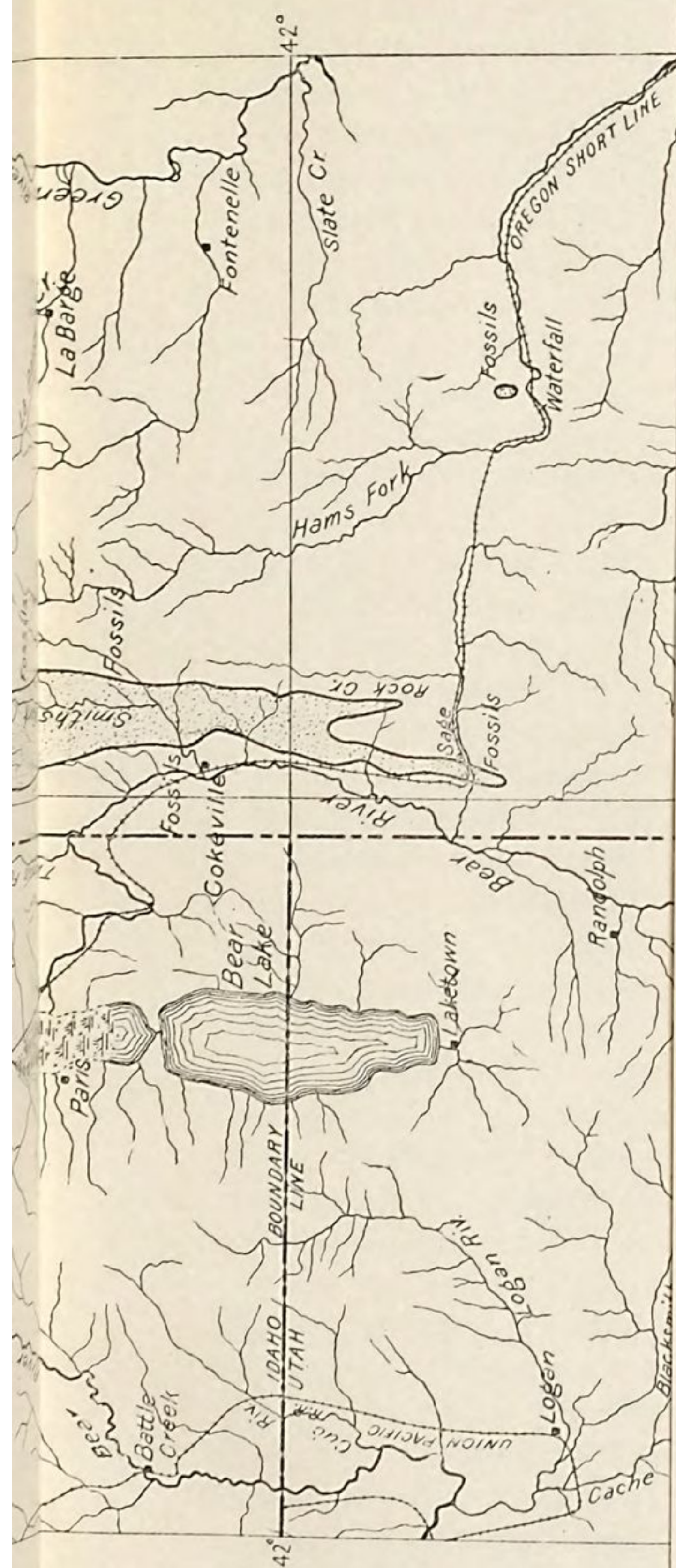
In connection with the subject of assumed identification of Bear River species at localities far distant from the district in which they were originally discovered, it is desirable to refer to the fauna of the Dunvegan series of strata which occur in Canada, especially those of the valley of Peace River. Through the kindness of Mr. J. F. Whitteaves, paleontologist to the Geological Survey of Canada, I have been able to compare a small suite of those fossils with the large collections of the Bear River fauna now in the United States National Museum. The species which most resemble members of the Bear River fauna are one each of the following genera: *Corbula*, *Corbicula*, *Modiola* (*Brachydontes*), and *Ostrea*.

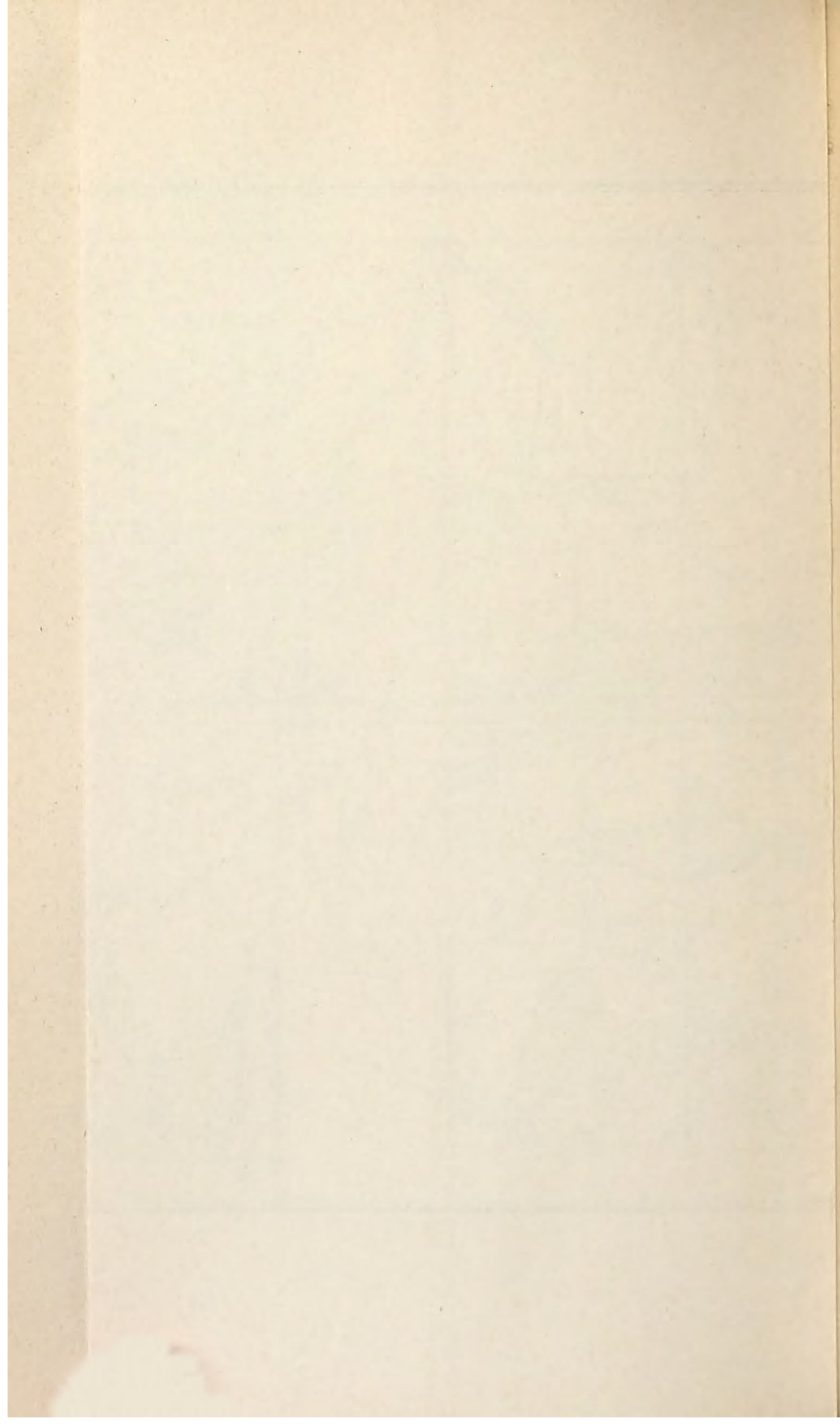
Some of these Dunvegan specimens of *Ostrea* are exceedingly like some of those which are found in the Bear River strata. They are also much like some of those found in various other formations, as well as some living forms. The *Modiola* is very like the *M. multilinigera* of Meek, and consequently very like the form in the Bear River formation

¹ It should be observed that these errors are the result of museum study only of the fossils in question. The same investigators who made them could not have done so if they had then had the opportunity of field work in connection with their paleontological study.



SKETCH MAP SHOWING AREAS OCCUPIED BY BEAR RIVER FORMATION.





to which on a following page I have proposed the conventional name of *M. pealei*.

The Dunvegan Corbicula is quite variable in shape and marginal outline, but some of the specimens are so nearly like those of *C. durkeei* that they would hardly be regarded as specifically different if found associated with genuine specimens of that species in Bear River strata. Other specimens are so closely like those forms of Corbicula or Cyrena which have been mentioned as occurring in the Colorado formation that one can not say how they differ specifically.

Of all the species obtained from the Dunvegan strata the one which most deserves attention in this connection is the Corbula. This is so exceedingly like *C. pyriformis* that if found associated with unquestionable members of the Bear River fauna one would hardly be justified in separating it. Still, in the absence of such association, and in view of the general want of salient features in the shells of Corbula by which the species may be discriminated, I think one is justified in rejecting this Dunvegan form as a specific representative of *C. pyriformis*.

The other species of Dunvegan fossils which were sent me for examination by Mr. Whiteaves belong to the genera Goniobasis, Neritina, Unio, Corbula?, and Mactra?, but none of them is identifiable with any member of the Bear River fauna. I therefore regard the Dunvegan fauna, although allied to that of the Bear River formation, as in no such sense identical with it as would imply a true geological equivalency of the formations respectively containing them. Besides this, the Canadian geologists are disposed to regard the Dunvegan and Belly River series of strata as belonging to one and the same horizon, and the position to which they assign the latter is somewhat later than that which has now been determined for the Bear River formation.

It is evident from the foregoing explanations that the Bear River fauna is not represented as a fauna beyond the limits of the district which is indicated by the accompanying sketch map (Pl. I), and it is probable that no really specific member of it exists beyond those limits.

For the third of the reasons mentioned on page 27 why our knowledge of the area occupied by the Bear River formation has been imperfect, it has not been found practicable to prepare for this bulletin a satisfactory detailed geological map of the district in question. The accompanying sketch map, however, embraces the extreme limits of the district in which the Bear River strata have been certainly recognized, and its shaded portions indicate the areas within which they have been observed or confidently assumed to exist.

These areas are in part copied from map 2 of the Twelfth Annual Report United States Geological and Geographical Survey of the Territories, which is based upon the reports of Dr. A. C. Peale and Prof. O. St. John, and in part from maps 2 and 3 of the atlas of the United States Geological Exploration of the Fortieth Parallel. The outlines of the areas which upon the copied portions of the two Fortieth

Parallel maps are designated Laramie are somewhat modified and restricted upon the sketch copy here presented, to make them accord with observations made by Mr. Stanton and myself. Those which are copied from the map by Dr. Peale and Professor St. John have been largely verified and identified by Mr. Stanton as Bear River areas up to 20 miles north of Cokeville. Northward from that point all the areas which are designated Laramie upon the last-named map are those which are confidently assumed to be occupied by Bear River strata, although the fact of that identity has not yet been verified by collections of fossils from all of them.

The shape, position, and limitation of those shaded areas bear no necessary relation to the limits of the Bear River formation as it was originally deposited. Those original limits have not yet been even approximately determined, and it is not likely that they will ever be much more definitely known. Their present limitation, as it is shown by their respective outlines upon the map (Pl. I), is due to causes which have transpired since their deposition took place. That is, it has been accomplished by the great disturbance which the strata of the whole district have suffered, by the outflow of great masses of volcanic rock, and by the extensive erosion and denudation which followed those events. These areas therefore represent only minor portions of the Bear River formation as it was originally deposited.

While it is evident that this formation as it was originally deposited occupied a larger total area than that which would be indicated by a line merely circumscribing that group of comparatively small irregular areas, we have now no satisfactory evidence that its original limits extended much, if any, beyond the limits of the district which is represented by the accompanying map, and which, for convenience in these discussions, I designate the Bear River district. It is true that a part of the region surrounding the district is occupied by Tertiary sedimentary deposits, and a smaller part by post-Cretaceous lava outflows, either of which would have covered from view any Bear River strata which may have existed there. Still, there are some other localities in the surrounding region at which equivalents of either a part or all of the marine strata of the Sulphur Creek section exist, but no equivalents of the Bear River strata have been paleontologically recognized in association with them, and in most of these cases there is no physical indication of their existence.

One of the most important of these localities is in the valley of Weber River, about 30 miles southwestward from the mouth of Sulphur Creek. Here, as has already been stated on page 24, the marine members of the Sulphur Creek section are well represented, and among them are certain strata which possibly represent the Bear River formation. This question, however, can not be decided without the discovery of its characteristic fossils, and its southern limit may therefore be provisionally supposed to lie somewhere between Sulphur Creek and Weber Valley.

Another important locality at which equivalents of the marine members of the Sulphur Creek section occur is at Flaming Gorge, Green River, and in the district extending east and west from that river along the north flank of the Uinta Mountains. This district embraces the boundary line between Colorado and Wyoming, and is from 50 to 70 miles eastward from the Sulphur Creek section. In this district the full series of strata from the Jurassic to the Laramie formation, inclusive, are exposed in the same order and in the same general condition that they are found to present throughout the Rocky Mountain region, but no trace of the Bear River formation is found among them.

The other exposures of the equivalents of the marine members of the Sulphur Creek section within the region surrounding the Bear River district are few in number, and less complete and important than are those of the two districts just referred to. Still, they are characteristic, but at none of them has any trace of the Bear River fauna been discovered, and no strata have there been recognized that may reasonably be referred to the Bear River formation.

It has already been shown that the supposed identity with members of the Bear River fauna of certain fossil forms found in eastern and southern Utah is fallacious. Furthermore, Mr. Stanton, who has carefully examined the geology of those regions for that purpose, was unable to find there any trace of the Bear River formation, even when representatives of the other members of the Sulphur Creek section were present.

In consideration of all the facts presented in the foregoing paragraphs, it seems quite unlikely that the Bear River formation ever occupied a much, if any, larger area than is represented by the extreme limits of the accompanying sketch map. This geographical isolation of the Bear River formation is still further emphasized by the comparison of its fauna with other North American fossil faunas which is presented on following pages. Its taxonomic isolation is also apparent because of its absence from all known sections of strata which occur beyond the geographical limits which have been designated.

DESCRIPTION OF SPECIES.

MOLLUSCA.

CONCHIFERA.

Family OSTREIDÆ.

Genus OSTREA Linnæus.

OSTREA HAYDENI n. s.

Plate II, figs. 1, 2.

Ostrea ———? White, Eleventh Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 242.

Among the collections which from time to time have been obtained from the Bear River formation are numerous examples of a small oyster belonging to the typical section of the genus *Ostrea*. These are so closely like specimens which have been found in the Colorado, Montana, and Laramie formations, respectively, that it is impracticable to describe them in terms which would not apply nearly or quite as well to those forms. Their resemblance to certain specimens of the young of the living *Ostrea virginica* is also quite as close as it is to the fossil forms just mentioned. For these reasons the propriety of giving a separate specific name to this fossil form might well be questioned, but I have decided to do so because it will add to the convenience of discussing the formation in which the shells occur and the fauna as a whole which characterizes it. The name which I have chosen is given in memory of Dr. F. V. Hayden, whose collections contained the first discovered specimens.

Although several others of the various species which constitute the fauna of the Bear River formation, especially those whose congeners are brackish-water denizens, are found in immediate association with this little oyster, it is usually confined to separate thin layers, which in some cases it almost entirely constitutes. Its geographical distribution, however, has been found to be nearly or quite coextensive with the present known limits of the formation.

The small size of all the discovered specimens, the largest not much exceeding 50^{mm} in length, gives one the impression that they are all immature, but the average size is about the same at all the localities at which they have been discovered, some of which are more than 100 miles apart. The shells are therefore regarded as mature notwithstanding their small size.

The localities at which this form has been found to be more abundant than at any others are 20 miles north of Cokeville, 7 miles north of Evanston, and near the mouth of Sulphur Creek.

Family MYTILIDÆ.

Genus MODIOLA Lamarck.

MODIOLA PEALEI n. s.

Plate II, fig. 3.

Compare *Modiola* (*Brachydontes*) *multilinigera* Meek, 1873, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1872, p. 492.

Compare *Volsella* (*Brachydontes*) *multilinigera* White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 18, pl. ii, fig. 3.

Among the collections which have been obtained from the Bear River formation are numerous fragments of a *Modiola* which in all observable characteristics closely resembles the *M. multilinigera* of Meek, the original specimens of which came from the Colorado formation. Indeed this Bear River form so closely resembles the one just mentioned that it would not be unreasonable to refer them to one and the same species if it were certainly known that the deposition of the Bear River formation was, as it seems to have been, followed immediately by that of the Colorado formation. Because of this doubt and of the imperfection of the Bear River specimens, which is so great as to make it impracticable to clearly diagnose them specifically, I prefer to give them a separate name, as I have done in the case of the oyster with which they are associated. For this purpose I have selected the name of Dr. A. C. Peale, because he was among the first geologists to examine the Bear River formation after its discovery by Mr. Engelmann, and his collections contained the first observed specimens of this form.

Fig. 3 on Pl. II is of a young and imperfect example, somewhat enlarged. The forementioned characteristics of the shell have been observed mostly by means of fragments of larger examples.

Mr. Stanton obtained imperfect specimens of this form at several localities, and its geographical distribution is apparently the same as that of *Ostrea haydeni*.

Family UNIONIDÆ.

Genus UNIO Retzius.

UNIO BELLIPLICATUS Meek.

Plate II, figs. 4, 5, 6.

Unio belliplicatus Meek, 1870, Proc. Am. Philos. Soc., Vol. XI, p. 439.

Unio (Lexopleurus) belliplicatus Meek, 1871, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1870, p. 294.

Unio belliplicatus Meek, 1873, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1872, p. 478.

Unio belliplicatus Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 165, pl. 16, fig. 4, 4a.

Unio belliplicatus White, 1879, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1877, p. 242.

Unio belliplicatus White, 1883, Third Ann. Rept. U. S. Geol. Surv. p. 430, pl. 6, figs. 1, 2, 3.

The following is Mr. Meek's description of this form, copied from Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel, pp. 165-166:

Shell attaining a medium size, transversely subovate, the widest part being a little in advance of the middle, moderately convex, generally less than twice as long as high; anterior margin short, rather regularly rounded; posterior margin obliquely subtruncated, with a more or less convex outline, most prominent below, where it is obtusely subangular or abruptly rounded into the base; dorsal outline nearly straight, or more or less arched; base broad semiovate, being most prominent in advance of the middle, in large specimens generally a little sinuous posteriorly; beaks much depressed, or scarcely rising above the cardinal margin, oblique, and placed near the anterior end, not eroded; hinge moderately long, with cardinal and lateral teeth, so far as known, much as in *U. vetustus*. Surface ornamented by a series of very regular, distinctly defined, and generally simple plications, which commence very small, and closely approximated along the dorsal margin just before the beaks, and after slight curves radiate and descend obliquely toward the posterior basal margin, increasing in breadth and becoming more obtuse as they descend and diverge, and at last in large specimens becoming obsolete before reaching the margins; while another more or less similar series of plications sometimes originates along the cardinal margins behind the beaks, and descends obliquely backward and downward, so as to connect with those of the first-mentioned series along the posterior umbonal slopes at very acute angles, somewhat like we see on species of *Goniomya*. Marks of growth moderately distinct, becoming sometimes stronger or subimbriating near the margins.

The dimensions of this species were given by Mr. Meek in inches, the approximate metric equivalents of which are: Length, 70^{mm}; height, 38^{mm}; thickness, 20^{mm}. Later collections show that the species is very variable not only in size but in proportional dimensions, some being much more convex and some much shorter than others. This is in part shown by the figures on Pl. II; but other specimens in the collections, which, however, are too imperfect for satisfactory illustration, show the great variations just mentioned.

The plications also vary considerably in character, being much stronger upon the more robust specimens than upon others. In such

cases they often occupy a larger part of the anterior surface of the shell than is usual in other cases. It was upon the character of these plications that Mr. Meek at one time proposed to separate this species as the typical representative of a subgenus under the name of *Loxopleurus*, but this proposition he afterwards abandoned. The peculiar character and direction of these plications constitute a striking feature of this species, but they really consist of a blending of concentric and radiating folds, which, when occurring separately, constitute ordinary features of ornamentation among the Uniones.

This species has a wide geographical distribution in the Bear River formation; but it has been found more abundant at the locality near the mouth of Sulphur Creek than at any others.

UNIO VETUSTUS Meek.

Plate III, figs. 1, 2, 3, 4.

Unio vetustus Meek, 1860, Proc. Acad. Nat. Sci. Phila., Vol. VIII, p. 117.

Unio vetustus Meek, 1876, Simpson's Rept. Great Basin of Utah, p. 359, pl. v, figs. 12, a, b.

Unio vetustus Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 164, pl. 16, figs. 5, a, b, c.

Unio vetustus White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 430, pl. 7, figs. 1-4.

The following is Mr. Meek's description of this species, as given in Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel (loc. cit.):

Shell of about medium size, transversely subovate or subelliptic, the widest part being anteriorly, though young examples are narrower, with dorsal and ventral margins more nearly parallel, rather thin and moderately convex, about twice as long as high; base forming a long semi-elliptic or semi-ovate curve in adult shells, but usually straighter in the young; posterior margin rather narrowly rounded below in large specimens and obliquely truncated in small examples; dorsal margin nearly straight, excepting in large shells, where it is more arched; anterior margin short and rounded; beaks depressed, not eroded, placed near the anterior, very neatly ornamented with small, perfectly regular, concentric ridges and furrows, that generally end abruptly behind at a small, oblique, linear, posterior umbonal ridge extending backward and downward, while midway between this and the cardinal margin there is a second similar ridge; other portions of the surface merely marked with lines of growth, which sometimes assume a subimbricating appearance near the free margins. Hinge of moderate length, with two cardinal teeth in the left valve, the posterior one being larger than the other; lateral teeth long and nearly straight (cardinal teeth of right valve unknown); scars of anterior muscles deep and irregularly pitted.

The dimensions of this species, like those of the preceding one, were given by Mr. Meek in inches, the approximate metric equivalents of which are: Length, 100^{mm}; height, 53^{mm}; thickness, 27^{mm}. This species, however, is very variable in its proportional dimensions as well as in marginal outline. These differences are in part shown by the figures on Pl. III.

The concentric ridges upon the umbones, which are mentioned by Mr. Meek, are in some cases quite as distinct as they are upon *U. belliplicatus* before they diverge as radiating folds. Indeed the surface markings of very young specimens of both species were evidently often closely similar.

Both Mr. Meek and myself at one time thought this form to be identical with one which occurs in the upper part of the Laramie, and with another which occurs in the lower part of the Wasatch formation. These were *U. priscus* Meek and Hayden, from near Fort Union, N. Dak., and *U. mendax* and *U. rectoides* White, from the base of the Wasatch formation in Utah. It is true that these forms are closely similar to *U. vetustus* when the great variation of the latter is taken into consideration, but there are recognizable differences between them. Besides this, *U. vetustus* is now known to belong to a much older stratigraphical horizon than do the other forms mentioned. It is therefore regarded as inexpedient to give them all the same name, even if it were still more difficult to discriminate between them.

The geographical distribution of this species within the Bear River formation is the same as that of *U. belliplicatus*, and they are usually found in intimate association. Both have been found more abundant at the Sulphur Creek locality than elsewhere.

Family CYRENIDÆ.

Genus CORBICULA Megerle.

CORBICULA DURKEEI Meek.

Plate IV, figs. 1, 2, 3, 4.

Cyrena (*Corbicula*?) *durkeei* Meek, 1870, Proc. Am. Philos. Soc. Phila., Vol. XI, p. 431.

Corbicula (*Veloritina*) *durkeei* Meek, 1872, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1870, p. 294.

Corbicula (*Veloritina*) *durkeei* Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 167, pl. 16, figs. 6, a, b, c, d, e, f, g.

Corbicula (*Veloritina*) *durkeei* White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 437, pl. 8, figs. 8, 9, 10, 11.

The most complete diagnosis of this species given by Mr. Meek occurs in Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel, pp. 167-168, which is as follows:

Shell attaining a large size, thick, trigonoid-subcordate, gibbous, oblique, with length exceeding somewhat the height, most convex a little in advance of and above the middle, and cuneate postero-ventrally; posterior dorsal slope long, straight, or slightly convex in outline from the umbones to the angular or subangular posterior basal extremity; basal margin sem-iovate in outline, being most prominent anteriorly; anterior margin short, descending very abruptly from the beaks, with a slightly concave outline above, and rounding regularly into the base below; beaks elevated, gibbous, obliquely incurved, contiguous, and placed about halfway between the middle and the anterior end, or sometimes nearly over the latter; posterior umbonal slopes prominently rounded, with posterior dorsal margins inflected or incurved, so as to form a profound, broad concavity, or sulcus, along their entire length, as the two valves are seen united; lunule in most cases deep, but generally

without well-defined margins; ligament short, narrow, and so deeply seated in the broad dorsal concavity as not to be visible in the side view when the valves are united; surface only showing moderately distinct lines of growth; hinge strong; cardinal teeth oblique, excepting the anterior one, which ranges nearly vertically; lateral teeth elongated, and only very minutely striated, or very nearly smooth, the posterior one of the left valve being sometimes mainly formed by the beveling of the inflected edge of the valve instead of standing out at right angles from an erect margin; pallial lines with a short, very shallow sinus, immediately under the ovate, shallow, and oblique scar of the posterior abductor muscle; anterior muscular impression deeper, slightly smaller than the other, and ranging nearly vertically.

As was his custom, Mr. Meek gave the dimensions of this shell in inches, the approximate equivalents of which are: Length, 47^{mm}; height, 39^{mm}; thickness, 28^{mm}.

This species, as was noticed by Mr. Meek in connection with its original publication, and as is shown by the figures on Pl. IV, is very variable in its proportions and marginal outline. Indeed the extremes which in this respect are observable among a large series of specimens are so great that if no intermediate forms were discovered no one would hesitate to assign them to different species. The recognition of this extreme interspecific variation led me to assign to this species some examples of a closely similar shell which were found near the north fork of Virgin River in southern Utah.¹ It has since been ascertained, however, that those specimens came from the lower part of the Colorado formation, and that its faunal associates are of distinctly marine character.

There is another form, possibly belonging to the same southern Utah species, which was obtained from the Colorado formation in the valley of Sulphur Creek near where the strata of the Bear River formation are exposed, and where it was associated with a fully marine fossil fauna. To this form I first gave the name of *Cyrena (Veloritina) erecta*, but afterwards referred it to the *Cyrena securis* of Meek.²

The form obtained from southern Utah was referred to *C. durkeei*, not only because its own characteristics are similar to those of that species, but because some of its associates so closely simulate other Bear River species that I then thought them identical, although they are now known to be different. The form discovered in the valley of Sulphur Creek, while I recognized its close similarity to *Corbicula durkeei*, I regarded as belonging to a different genus and species. I accordingly referred it to the marine genus *Cyrena*, because I could discover no striation of the lateral teeth, which character is absent in *Cyrena* and present in all known North American fossil forms of *Corbicula*, and because the specimens were found as members of a distinctly marine fauna, while the associates of *Corbicula durkeei* are fresh-water and brackish-water forms.

Still, the striation of the lateral teeth of *Corbicula durkeei* is never strongly marked, and it has not been fully demonstrated that those of

¹ U. S. Geog. Surv. West of the One Hundredth Merid., Vol. IV, p. 207, pl. xxi, fig. 13, 1877.

² Eleventh Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 289, pl. 3, figs. 2, a, b, c, 1879.

Cyrena securis were not at least indistinctly striate. These facts lead to a suggestion similar to that which was made in the case of *Modiola pealei* on a preceding page. That is, they make it reasonable to inquire whether the forms found in the Colorado formation in southern Utah and in Sulphur Creek Valley in southwestern Wyoming may not have been genetically derived from *Corbicula durkeei* by survival from the brackish waters in which the Bear River formation was deposited into the marine waters of the Colorado formation. This suggestion of course implies that there may have been continuous sedimentation in the production of the Bear River and Colorado formations. This condition has not yet been demonstrated, but it is known that the Colorado formation rests immediately upon the Bear River strata, and no facts are yet known that forbid the supposition that sedimentation was, at least in part, continuous from the former to the latter formation.

Mr. Meek proposed the subgeneric name *Veloritina*¹ for this shell, and this designation has been generally used by American authors. It will be seen, however, that the characters which he designates as subgeneric are the unusual proportional height of the shell and the depression of the dorsal margin. The interspecific variations which have been mentioned, and which are in part shown by the figures on Pl. IV, are such as to include forms in which these characters are entirely absent. This fact renders of doubtful value any subgeneric designation as regards this species.

It is worthy of remark that although *Corbicula durkeei* is so abundant in the Bear River formation it is the only representative of the family Cyrenidæ that has yet been found in its strata.

This species is one of the most abundant and characteristic of the members of the Bear River fauna. It is particularly plentiful 7 miles north of Evanston, and also near the mouth of Sulphur Creek, but its geographical range is throughout the whole extent of the formation so far as its strata have been examined.

Family CORBULIDÆ.

Genus CORBULA Bruguiere.

CORBULA PYRIFORMIS Meek.

Plate IV, figs. 5, 6, 7, 8, 9.

Corbula (*Potamomya*) *pyriformis* Meek, 1860, Proc. Acad. Nat. Sci., Vol. XII, p. 312.

Corbula (*Anisorhynchus*) *pyriformis* Meek, 1872, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1871, p. 292.

Corbula (*Anisorhynchus*) *pyriformis* Meek, 1876, Simpson's Rept. Great Basin of Utah, p. 361, pl. 5, figs. 9, 10.

Corbula (*Anisorhynchus*) *pyriformis* Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 170, pl. 17, figs. 2, a, b, c, d.

Corbula pyriformis White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 441, pl. 8, figs. 12-16.

¹For its diagnosis see U. S. Geol. and Geog. Surv. Terr., Vol., IX, p. 161, 1876.

Mr. Meek's most complete description and discussion of this form is contained in Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel, pages 170 to 174. The following is a copy of his description:

Shell attaining a large size, rather thick, oval-subpyriform, nearly equivalve, very gibbous in the central and anterior regions, and much more compressed, narrowed, and produced posteriorly; beaks elevated, nearly equal, incurved, and placed more or less in advance of the middle; anterior side generally truncated obliquely forward above, from the beaks to near the middle, thence rounding abruptly to the base; posterior side much attenuated, and usually slightly truncated at the immediate extremity; dorsal margin generally much concave in outline behind the beaks, and provided with a well-defined marginal carina, extending in each valve from the beaks nearly to the posterior extremity, and between these carinae with a deeply excavated lanceolate escutcheon; basal margin deeply rounded in the central and anterior region, and more or less sinuous in outline behind the middle; lunule deeply and rather largely impressed, without being always distinctly defined, though it is sometimes margined by a subangular ridge on each side. Surface ornamented with concentric ridges and furrows, most regularly and strongly defined on the umbonal region, and gradually becoming more irregular and less distinct toward the basal margin, or in some cases entirely fading away, so as to leave only the lines of growth over the whole exterior. Hinge with the tooth of the right valve rather thick, prominent, subtrigonal, striated, and a little curved upward; cartilage-pit deep and trigonal; hinge of left valve with pit and cartilage-process, presenting the usual characters; pallial line with apparently a small shallow sinus; posterior muscular impression very faintly marked; anterior muscular impression generally well defined, subovate, attenuated, and curving backward above where they connect with the small scars of the pedal muscles.

This species varies considerably in form as well as in surface-markings. In some specimens the whole surface is nearly smooth or only marked with obscure lines of growth, while in others the most gibbous part of the valves and the umbones are marked with very regular, distinct, concentric ridges and furrows. In still others the ridges and furrows are exceedingly irregular and very strongly marked. There are also more or less marked differences in the elevation of the beaks, the convexity of the anterior region, and the proportional length of the attenuated posterior extremity; yet all of these varieties blend together by such slight shades of difference that it seems impossible to find constant characters by which they can be separated specifically.

This species is an unusually large one for the genus *Corbula*, besides which it is unusually obese. The length of one of the larger examples is 40^{mm}; height, 29^{mm}; and thickness, 26^{mm}.

Mr. Meek regarded this form as representing a subgenus under *Corbula*, and he adopted for it Conrad's MS. name, *Anisorhynchus*;¹ but, as Mr. Meek has himself shown, it possesses no features which properly separate it from true *Corbula*. It is a conspicuous member of the Bear River fauna, not only because of its large size, but because of its abundance. Its geographical range is throughout the whole known extent of the formation, but it is most abundant at the locality 7 miles north of Evanston and at the one near the mouth of Sulphur Creek.

¹ For Mr. Meek's diagnosis of *Anisorhynchus*, see U. S. Geol. and Geog. Surv. Terr., Vol. IX, p. 241, 1876.

CORBULA ENGELMANNI Meek.

Plate IV, figs. 10, 11.

Corbula (*Potamomya*?) *engelmanni* Meek, 1860, Proc. Acad. Nat. Sci. Phila., Vol. XII, p. 213.

Corbula engelmanni Meek, 1876, Simpson's Rept. Great Basin of Utah, p. 362, pl. 5, figs. 13, a, b.

Corbula (*Anisorhynchus*?) *engelmanni* Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 174, pl. 17, figs. 1, 1a.

All the larger collections of fossils that have been obtained from the Bear River formation contain a greater or less number of specimens of the form to which Mr. Meek gave the name *Corbula engelmanni*. Ever after its first publication, however, he felt much doubt whether it was really distinct from *C. pyriformis*, and I also have been disposed to regard this form as the young of that species, but there are certain facts which still suggest the separate specific identity of *C. engelmanni*, among which are the following: First, the outline of the form to which the name *C. engelmanni* has been applied rarely if ever fully agrees with that of *C. pyriformis* of similar size, as it is indicated by the lines of growth on adult specimens of the latter; second, the strong convexity of the valves and the incurving of the beaks which are characteristic of *C. pyriformis* are not observable on any of the shells which have been referred to *C. engelmanni*; third, no forms have been discovered which in size and shape are intermediate between *C. engelmanni* and *C. pyriformis*; fourth, the form *C. engelmanni* bears a much closer resemblance to the *C. nematophora* Meek of the Colorado formation than it does to *C. pyriformis*.

The last-named fact suggests a genetic survival of the form *C. engelmanni* from the waters in which the Bear River formation was deposited into those of the Colorado formation, the case thus suggested being similar to those which have been suggested on preceding pages for *Ostrea haydeni*, *Modiola pealei*, and *Corbicula durkeei*.

This form generally occupies different layers from those in which *C. pyriformis* prevails, and is frequently found in the same layers with *Unio belliplicatus* and *U. vetustus*. It is widely distributed in the Bear River formation, and is somewhat plentiful at some of the localities, but it is never so abundant as is *C. pyriformis*.

Genus CORBULOMYA Nyst.

CORBULOMYA TAUSCHII n. s.

Plate IV, figs. 12, 13.

Shell of moderate size, generally suboval, but sometimes subtriangular in marginal outline; front somewhat narrowly rounded; base broadly convex; posterior narrowly rounded but not attenuated nor much extended; dorsal border sloping with little convexity from the umbones to

the posterior margin; anterior obliquely truncate; lunule rather large, moderately deep, and margined by a more or less distinct angulation. Surface marked by somewhat distinct lines of growth and by small, irregular, concentric folds. Posterior tooth of the left valve strong, anterior one small, cartilage pit large. Teeth of the right valve unknown.

Length of the largest valve in the collection, which is suboval in marginal outline, 29^{mm}; height, 20^{mm}. Length of another example, which is subtriangular in marginal outline, 22^{mm}; height, 17^{mm}. The latter example is not referred to this species with entire confidence.

If only the hinge structure of this shell is considered, it is difficult to say how it differs from typical *Corbula*; but I refer it to *Corbulomya* because of its generally suboval marginal outline, its thin test, and its want of the posterior extension or attenuation and of the postero-dorsal carinae, which usually characterize true *Corbula*.

The specific name is given in honor of Dr. Leopold von Tausch, of Vienna, who has done so much to make known the Hungarian fossil fauna, which in many respects so much resembles that of the Bear River formation.

This species was discovered at only one locality, which is near Sage Station, in Twin Creek Valley, Wyoming; but it was found associated with several characteristic species of the Bear River fauna.

GASTEROPODA.

Family AURICULIDÆ.

Genus AURICULA Lamarck.

AURICULA NEUMAYRI n. s.

Plate V, fig. 1.

Shell small, subfusiform; spire, short; volutions about six in number, those of the spire convex, the last one large, elongate, and subterete; suture moderately impressed; columella bearing three folds, all of which are prominent, but the middle one strongest and most nearly transverse in direction, the anterior one smallest; outer lip plain, moderately thickened in the adult, but sharp in immature examples. Aperture comparatively narrow and narrowly rounded in front, but ending anteriorly in a sharp angle. Surface marked by lines of growth which are often strong and somewhat irregular.

Length, 12^{mm}; diameter, 5^{mm}.

In its generic characteristics this form so nearly agrees with typical species of *Auricula* that, although its antiquity is suggestive of a generic difference in the animal, I do not see how the shell can with propriety be referred to any other genus. It is also an interesting fact that the family Auriculidæ is so fully represented in this formation as it is shown to be by the presence of this and the four following species.

The specific name is given in memory of the late Prof. M. Neumayr, of Vienna, whose important works upon the nonmarine fossil fauna of Austria-Hungary are well known.

The geographical range of this species was doubtless coextensive with other members of the fauna, but the only examples yet known are those which Mr. Stanton discovered at the locality 20 miles north of Cokeville, Wyo.

Genus MELAMPUS Montfort.

MELAMPUS CLARKII n. s.

Plate V, figs. 2, 3.

Shell small, subovate or subfusiform; spire short, its apex prominent; volutions five or six in number, those of the spire narrow and convex, that of the apex deflected or reversed; the body volution comprising much the greater part of the bulk of the shell, broadest at its distal part and tapering toward its proximal end; suture impressed and accompanied at its proximal side by a slightly impressed revolving line; aperture narrow, rounded in front and sharply angular behind; outer lip thin; inner lip more or less calloused and bearing three teeth; the upper tooth prominent, narrow, and inclining a little forward; middle tooth also prominent and inclining a little backward; the anterior tooth small and situated near the front of the aperture. Surface smooth or marked by more or less distinct lines of growth.

The largest specimens discovered are from 4 to 6^{mm} in length. They appear to be mature or nearly so, but it is probable that the species attains a greater size than the discovered specimens indicate.

The only specimens discovered were obtained by dissolving in acid the pieces of impure limestone which were obtained by Mr. Stanton 20 miles north of Cokeville, Wyo., where they were associated with *Tortacella haldemani* and several other minute forms herein described.

The specific name is given in honor of Prof. W. B. Clark, of Johns Hopkins University.

It is probable that the animal which constructed the shells here described was not really congeneric with those living forms which are classed under the genus *Melampus*, but the features presented by these fossil shells are so nearly like those of the shells of living species of *Melampus* that I am not able to satisfactorily refer it to any other genus. It is evidently congeneric with the *Melampus antignus* of Meek, from the brackish-water Cretaceous deposit near Coalville, Utah.

Genus RHYTOPHORUS Meek.

RHYTOPHORUS PRISCUS Meek.

Plate V, figs. 4, 5.

Melampus priscus Meek, 1860, Proc. Acad. Nat. Sci. Phila., Vol. XII, p. 315.

Rhytophorus priscus Meek, 1872, Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 478.

Rhytophorus priscus Meek, 1876, Simpson's Rept. Great Basin of Utah, p. 364, pl. 5, figs. 4, a, b.

Rhytophorus priscus Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 175, pl. 17, figs. 6, 6a.

Rhytophorus priscus White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 44, pl. 8, figs. 2, 3.

Although Mr. Meek gave the generic name *Rhytophorus* to this form in 1872, and it was so used by himself and others during the following years, no diagnosis of the genus was published until 1877, when it appeared in Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel, page 175. The same page also contains Mr. Meek's description of the species, as follows:

Shell obovate, about once and a half as long as wide; spire depressed-conical; whorls about five, convex, or faintly subangular; last one large, somewhat shouldered above, and tapering below the middle; suture well defined; surface marked by rather obscure lines of growth, and the small, regular, vertical, or slightly oblique folds, which are distinct on the volutions of the spire, and around the upper edge of the body-whorl, but obsolete on all the surface below this; aperture narrow, angular above, and apparently very narrowly rounded below; outer lip sharp and apparently smooth within; columella provided with one rather strong oblique fold below, and a much smaller, less oblique one about half-way up the aperture.

Length of Mr. Meek's type specimen, 22^{mm}; diameter of the same, 18^{mm}. Some examples, however, which Mr. Stanton found near Sage Station, about 60 miles north of Sulphur Creek, where the species was originally discovered, show that it sometimes reached a much larger size. One of these specimens, when perfect, was not less than 30^{mm} in length.

This species has been found at only the two localities just mentioned, but it is probable that its geographical range was coextensive with the formation.

RHYTOPHORUS MEEKII White.

Plate V, figs. 6, 7.

Rhytophorus meeki White, 1876, Powell's Rept. Geol. Uinta Mts., p. 118.

Rhytophorus meeki White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 82, pl. 30, figs. 8, a, b.

Rhytophorus meeki White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 444, pl. 8, figs. 4, 5.

Shell subfusiform; spire moderately extended, its length a little less than one-third the entire length of the shell; volutions about six in number, those of the spire convex, the last one large, elongate, subterete; suture impressed, and upon the proximal side of and near it

there is an almost equally impressed revolving narrow furrow which has the appearance of a second suture; posterior fold of the columella well developed; the anterior one small. Surface marked by ordinary lines of growth, and also, upon the spire, by numerous small varices or longitudinal folds which cross the volutions in a direction slightly oblique to the axis of the shell, but nearly parallel to the lines of growth. These varices appear on only the distal portion of the last volution, but they cross the entire exposed portion of the volutions of the spire.

Length of the most perfect of the type specimens, 20^{mm}; diameter, 9^{mm}; but other specimens have a length of about 25^{mm}.

There is some reason to believe that this form is only a variety of *R. priscus* Meek; but the difference between typical examples of the two forms as they have heretofore been recognized is so great that it is still thought inexpedient to place them together.

Typical examples of *R. meeki* have as yet been found only at the locality near the mouth of Sulphur Creek.

Genus TORTACELLA gen. nov.

Shell slender, resembling in outward form that of the genus *Acella* Haldeman, but, unlike the shells of that genus, it bears two more or less prominent oblique folds upon its columella; outer lip plain, slightly thickened in the adult state; aperture elongate, rounded in front and sharply angular or narrowly subtruncate behind. Type, the *Acella haldemani* of White, which is at present the only species known

TORTACELLA HALDEMANI White.

Plate V, figs. 8, 9, 10, 11, 12.

Acella haldemani White, 1878, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. IV, p. 714.

Acella haldemani White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 84, pl. 30, figs. 9, a, b.

Acella haldemani White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 445, pl. 6, figs. 18, 19.

Shell very small and very slender; spire much extended, longer than the aperture; volutions very obliquely coiled, about six in number, those of the spire broadly convex, or with a tendency to become flattened at the middle, the last one comparatively large but not ventricose; aperture elongate and narrow, especially behind, a little obliquely rounded and sometimes slightly expanded at the front, sometimes narrowed at the middle by the slight flattening of the volutions just mentioned. Surface marked by numerous fine raised lines, visible under a lens, which correspond in direction to the lines of growth and which are separated by spaces of about equal width with the lines. The direction of these lines is only slightly oblique to the axis of the shell. Outer lip slightly thickened in adult specimens, the two columellar folds of about equal size, situated near each other at the mid length of the inner lip.

Length of adult example, 6^{mm}; diameter of the last volution, a little less than 1½^{mm}.

All the specimens of this species which the collection contains have been obtained in the condition of chalcedonic pseudomorphs¹ by dissolving in acid pieces of the impure limestone layers in which they, together with many other small shells, were embedded. They have not been discovered in any other condition, and without the aid of the process which has just been mentioned it is not likely that this species would have been discovered. Even by this means it was not until lately discovered that it bears two folds upon the columella and that it therefore does not belong to the genus *Acella*, to which it was originally assigned.

Family LIMNÆIDÆ.

Genus LIMNÆA Lamarck.

LIMNÆA NITIDULA Meek.

Plate VI, figs. 1, 2, 3.

Melania ? nitidula Meek, 1860, Proc. Acad. Nat. Sci. Phila., Vol. XII, p 314.

Limnæa (Limnophysa) nitidula Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 181, pl. 17, figs. 5, 5a.

Limnæa (Limnophysa) nitidula White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 445, pl. 6, figs. 15, 16.

The following is Mr. Meek's description of this species as given in Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel, p. 181:

Shell small, ovate-subfusiform; spire conical, moderately elevated; volutions about six and a half, convex, last one forming two-thirds of the entire length; suture well defined; aperture sub-ovate, narrowly rounded below and angular above, scarcely equaling one-half of the length of the shell; columella apparently with only a very small fold, and showing by the side of the inner lip below appearances of a small umbilical indentation. Surface marked by fine, rather obscure lines of growth, with (on some specimens) exceedingly faint traces of microscopical revolving striæ.

Length, 10^{mm}; diameter of the last volution, 5^{mm}.

Ever since the first publication of this species more or less doubt has prevailed as regards its specific and generic characters, the locality and formation from which it was first obtained, and the identity of the type specimens. I have hitherto been somewhat disposed to regard it as identical with the form which is described on a following page under the name of *Charydrobia stachei*, and I should therefore have rejected it from this summary of the fauna of the Bear River formation if it were not that a considerable number of specimens have lately been obtained which conform well to the original description as published by Mr. Meek. The specimens believed to be those which were thus originally used by him are figured on Pl. VI. They are preserved in the collections of the United States National Museum, accompanied by a label in

¹For an explanation of this condition, see Rept. U. S. Nat. Museum for 1892, p. 265.

Mr. Meek's handwriting, referring them to this species. The examples figured by Mr. Meek in Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel, and copied by me in the Third Annual Report of the United States Geological Survey, are unlike these specimens, and unlike any form known to me in the Bear River fauna, and they do not answer to Mr. Meek's description.

This species was originally discovered at the long-known locality near the mouth of Sulphur Creek, but specimens have since been obtained at other localities. Mr. Stanton found some examples of it at the locality 20 miles north of Cokeville, which were embedded in thin layers of impure limestone, from which they were obtained in the condition of chalcedonic pseudomorphs by its solution in acid, in the manner already mentioned.

The distance between that locality and the one at which this form was originally discovered is about 100 miles, which indicates that it has a wide range within the geographical limits of the formation.

Genus PLANORBIS Müller.

Subgenus GYRAULUS Agassiz.

PLANORBIS PRÆCURSORIS n. s.

Plate VI, figs. 4, 5, 6, 7.

Compare with *P. (G.) militaris* White, Third Ann. Rept. U. S. Geol. Surv., p. 447, pl. 28, figs. 10, 11.

Shell minute, subdiscoidal, the upper side flattened, sometimes slightly convex and sometimes very slightly concave, lower side umbilicate; volutions almost regularly rounded and about four or four and one-half in number; aperture nearly round, only slightly oblique to either the plane or diameter of the coil. Surface marked only by lines of growth.

Diameter of coil of the largest example obtained, 3^{mm}; diameter of aperture, about 1^{mm}.

This little shell is a typical example of the section of the genus Planorbis, to which Agassiz gave the name Gyraulus. It differs from the form which Dr. Hayden found in Jurassic strata at the southwest base of the Black Hills, to which Meek and Hayden gave the name *P. (G.) returnus*, in not having a depressed spire and in showing a less rapid increase in the size of the volutions. The *P. (G.) militaris* White (loc. cit.) which was obtained from the Wasatch formation of Utah more nearly resembles this form than does any other fossil form with which it need be compared, but because there is so much difference in the geological age of the formations from which they respectively come, and because the faunal associates of each are wholly different, the probability of the two forms being specifically identical is not considered.

The presence of this form in the Bear River strata near the mouth of Sulphur Creek has been known for several years, but satisfactory

examples of it have only lately been obtained. These were found by Mr. Stanton at the locality 20 miles north of Cokeville, and were obtained by dissolving in acid fragments of the layer of impure limestone, which has been mentioned in connection with the description of *Tortacella haldemani* and other species.

Its presence at localities so widely separated indicates that it had a wide distribution within the geographical limits of the formation in which it occurs.

Family PHYSIDÆ.

Genus PHYSA Draparnaud.

PHYSA USITATA n. s.

Plate VI, figs. 8, 9.

Physa ———? White, 1883, Third Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 449, pl. 6, fig. 17.

A collection of fossils which I obtained several years ago from the Bear River strata, near the mouth of Sulphur Creek, contained a single specimen of *Physa*, of which I afterwards published a figure (loc. cit.), but to which I then thought it inadvisable to apply a separate specific name. The collections which Mr. Stanton made in 1891 contain several other specimens of this form, two of which are figured on Pl. VI. All of these, like the one originally discovered, are imperfect, but they represent a typical species of the genus. Indeed, the proportions and general aspect of this shell are such that it is difficult to say how it differs specifically from certain well-known fossil and living species of *Physa*. It especially resembles those specimens of the common North American living species *P. gyrina* Say which have a comparatively short spire. Because of this close similarity to published species I have heretofore hesitated to give a separate name to this form, but I do so in this case for the sake of convenience in characterizing and discussing the fauna of the Bear River formation, and because it is presumably different from any published form. It is an interesting fact that this, the oldest species of *Physa* yet discovered in North America, should so closely resemble forms that are now living upon this continent.

All the discovered specimens of this form have been obtained in the condition of chalcedonic pseudomorphs by dissolving fragments of the embedding limestone in acid, as has been stated in connection with the description of preceding species.

Mr. Stanton's specimens were obtained at the locality 20 miles north of Cokeville, about 100 miles from the place at which the species were originally discovered. This fact indicates that it was generally distributed within the geographical limits of the formation in which it occurs.

Family HELICIDÆ.

Genus HELIX Linnæus.

HELIX? ———?

Plate VI, fig. 13.

Among the numerous small silicified shells obtained by dissolving in acid fragments of the fossiliferous limestone layer which Mr. Stanton discovered at the locality 20 miles north of Cokeville, Wyo., is a single small specimen which seems to be referable to some one of the sections into which the original genus *Helix* has been divided. The specimen is too incomplete for satisfactory diagnosis, and it is mentioned and figured here only for the purpose of giving as full a statement as possible of the fauna of the Bear River formation. It resembles the form which Dr. Stache has referred with doubt to the *H. cretacea* of von Tausch.¹

Genus TORNATELLINA Beck.

TORNATELLINA? ISOCLINA n. s.

Plate VI, figs. 14, 15.

Shell short, narrowly umbilicate, but the umbilicus often nearly or quite covered by a thin layer of callus, subfusiform or subglobose; spire short, its sides nearly straight; apex acute; volutions about seven in number, convex, the last one extending considerably forward at the aperture, rounded on the anterior side, from which it is narrowly rounded into the small umbilicus; aperture moderately large, but because of the imperfection of the specimens its shape is not fully known; outer lip plain; inner lip with a thin layer of callus, and upon the body of the shell at the inner side of the aperture there is a single, slightly raised, angular, revolving ridge, which extends backward within the shell and forward upon the inner lip, but it is hardly visible when the outer lip is complete; suture impressed. Surface marked by ordinary lines of growth.

The length of the largest example obtained was, when perfect, about 10^{mm}; diameter of the last volution, 7½^{mm}.

It is doubtful whether this shell really belongs to the genus *Tornatellina*, but its characteristics, so far as they are observable, agree more nearly with those of that genus than with those of any other shell known to me.

Mr. Stanton found the only known examples at the locality 20 miles north of Cokeville, Wyo. They are in the condition of chalcedonic pseudomorphs, and were obtained by dissolving in acid fragments of the thin layers of impure limestone containing them.

¹See Abhandl. K.-k. geol. Reichsanstalt, Wien, Band XIII, p. 167, pl. 4, fig. 30, 1889.

Family NERITIDÆ.

Genus NERITINA Lamarek.

NERITINA NATICIFORMIS White.

Plate VI, figs. 10, 11, 12.

Neritina naticiformis White, 1878, Bull. U. S. Geol. and Geog. Surv. Terr., Vol., IV, p. 715.

Neritina naticiformis White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 89, pl. 30, figs. 3, a, b.

Neritina naticiformis White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 430, pl. 7, figs. 5, 6.

Shell small, young examples subglobose and resembling *Natica* in general aspect, but adult examples expanded and subovoid in outline; spire moderately prominent; volutions four and a half or five in number, convex, a little more narrowly rounded at the posterior than at the anterior side, those of the spire rounded into the depressed suture, the last one in adult shells very large, the expansion being greatest in front; inner lip of moderate breadth, flat or slightly concave, its inner margin moderately sharp, slightly concave, toothless; outer lip thin; aperture large, suboval. Surface plain or marked by faint, fine, close-set, revolving lines, visible only under a good lens.

Antero-posterior diameter, 11^{mm}; transverse diameter, 8^{mm}.

This species was originally described (loc. cit.) from young examples, and the description was therefore not quite accurate. The examples used in the foregoing description were brought by Mr. Stanton from the locality 20 miles north of Cokeville, in Wyoming. They have been obtained in the condition of chalcedonic pseudomorphs by dissolving fragments of the embedding limestone in acid in the manner already mentioned in connection with the description of other species.

It has been found only at the locality just mentioned and at the one near the mouth of Sulphur Creek, but these two localities being 100 miles apart, it is reasonable to suppose that its dispersion was nearly or quite equal to the geographical limits of the formation in which it occurs.

NERITINA STANTONI n. s.

Plate VI, figs. 16, 17, 18.

Shell small, spire slightly elevated or sometimes nearly flat; volutions about four in number, flattened upon the distal side and broadly rounded upon the proximal side. The place of meeting of the two sides, which is the periphery of the shell, is more or less angular, and in typical examples is marked by a small revolving carina, which is sharp and prominent upon all the volutions, but it becomes obsolete near the outer lip of adult examples. Upon some examples evidently belonging to this species the carina is obsolete upon all parts, but the

subangularity at that part of such shells, together with their general characteristics, leaves no reasonable doubt that they, too, belong to this species. Inner lip not very broad, plain; aperture moderately expanded, broadly truncate posteriorly and somewhat narrowly rounded in front; outer lip thin. Surface marked by distinct lines of growth, and upon one of the examples two broad revolving bands of color-marking is still preserved.

Antero-posterior diameter of the largest example discovered, 9^{mm}; transverse diameter, 6^{mm}.

This species was found by Mr. Stanton in the thin layer of impure limestone at the locality 20 miles north of Cokeville, in Wyoming, where it was associated with *N. naticiformis* and other forms, which were obtained by dissolving fragments of the limestone in acid. He also obtained it in the ordinary condition from the locality near Sage Station, in the valley of Twin Creek.

Family MELANIIDÆ.

Genus PACHYMELANIA gen. nov.

Shell elongate, compact; test strong or more or less massive, which is largely owing to the deposit of callus upon the inner surface; volutions moderately convex or flattened, marked by longitudinal varices or revolving lines or by both, and both may be strong or obsolete, the last volution not inflated; suture distinct; aperture subovate, its posterior angle, which would otherwise be acute, is usually made obtuse by the deposit of callus, but the callus is not protuberant nor very thick; anterior portion of the aperture extended and rounded, outer lip sinuous, slightly thickened; inner lip covered with a layer of callus of moderate and nearly uniform thickness; columella arcuate.

These shells resemble the Cerithiidæ in aspect, but they are excluded from that family by the absence of any notch or canal in any part of the aperture. They differ from *Melanopsis* in this respect and in wanting a protuberance of callus upon the inner lip, although they somewhat resemble some forms of that genus in other respects. The character of the anterior portion of the last volution is much like that of *Goniobasis* Lea, to which genus both Mr. Meek and myself have referred it in former publications, but it differs from that genus in the moderate massiveness of the test and in a general habitus which is readily observable but difficultly describable. None of the species yet known shows any tendency to the production of spines or even of strong nodes. Type, the *Goniobasis cleburni* of White.

The only American species which I at present certainly refer to this genus are those which are described in the following paragraphs, all of which are members of the fauna of the Bear River formation. Few European fossil forms seem to be cogenetic with these, but it is probable that at least a part of the species published by Dr. G. Stache and

Dr. L. von Tausch and referred by them to *Goniobasis* are properly referable to this genus.¹ The characteristics of the living *Melania* (*Sermyla*) *admirabilis* Smith from Lake Tanganyika, in Africa, very closely resemble those of *Pachymelania*; but the test of that species appears to be less massive than is that of typical forms of this genus, and its aperture is not so much produced in front. The fact of such a resemblance is, however, an interesting one, because the African species is there associated with *Pyrgulifera*, as *Pachymelania* is thus associated in the Bear River formation.

PACHYMELANIA CLEBURNI White.

Plate VII, figs. 1, 2, 3.

Goniobasis cleburni White, 1876, Powell's Rept. Geol. Uinta Mts., p. 122.

Goniobasis cleburni White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 91, pl. 30, figs. 4, a, b, c, d.

Goniobasis cleburni White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 460, pl. 6, figs. 4, 5, 6.

Shell moderately large, tapering regularly from the apex, the sides of the spire being gently convex; volutions of adult shells ten or more in number, regularly increasing in size, the sides of those of the spire gently convex or nearly flat, the anterior half of the last volution broadly convex; aperture obliquely subovate in outline. Surface of the spire marked by numerous strong, slightly curved longitudinal ridges or varices, slightly stronger at the middle than at the ends, which extend from suture to suture in a direction a little oblique to the axis of the shell. Surface of the anterior side of the last volution marked by coarse, slightly raised revolving lines, and traces of smaller revolving lines are sometimes seen upon the spire, but these are seldom strong enough to crenulate the varices. The varices usually become obsolete near the aperture of adult shells, and in some cases they are obsolete upon one or more of the last volutions of the spire.

This species was first discovered at the locality near the mouth of Sulphur Creek, but it has been found at most of the localities at which fossils of the fauna of the Bear River formation have been obtained. Its distribution may therefore be regarded as equal to the geographical extent of the formation.

PACHYMELANIA CHRYSALIS Meek.

Plate VII, figs. 6, 7. Compare also with 8, 12, 13.

Goniobasis chrysalis Meek, 1871, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1870, p. 316.

Goniobasis chrysalis White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 91, pl. 30, figs. 6, a, b.

Goniobasis chrysalis White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 460, pl. 6, figs. 13, 14.

¹See Abhandl. K.-k. geol. Reichsanstalt, Wien, Band XIII, Heft I, 1889. Also idem, Band XII, No. 1, 1886.

The following is Mr. Meek's original description of this species (loc. cit.):

Shell generally almost cylindrical below the middle, but more abruptly tapering above, volutions six or seven, flattened, with the upper margin thickened, last one not angular, and scarcely larger than the next above it; suture well defined.

Surface ornamented by distinct vertical costæ, often ranged nearly in the same line all the way up the spire; these are partly interrupted by an effort to form three, or rarely four, obscure revolving lines or ridges, the upper of which is larger and more prominent than the others, which character, with the slightly enlarged upper ends of the vertical costæ, causes the thickened appearance of the upper margins of the volutions; several other slender and more distinct revolving lines also occur on the under side of the last turn. Aperture somewhat rhombic-ovate.

Mr. Meek's specimens were all small, and at the locality where the species was first discovered no other than small specimens have been found. He gives the length as about 17^{mm}; diameter, 5^{mm}. Among the collections which were brought by Mr. Stanton from other localities, however, are specimens evidently belonging to this species which when perfect were not less than 25^{mm} in length. The longer and more slender specimens are sometimes bent or distorted.

This form is generally found associated with *P. cleburni* and *C. chrysalloidea*, and its distribution seems to be throughout the whole geographical extent of the formation.

PACHYMELANIA CHRYSALLOIDEA White.

Plate VII, figs. 4, 5.

Goniobasis chrysalloidea White, 1876, Powell's Rept. Geol. Uinta Mts., p. 123.

Goniobasis chrysalloidea White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 92, pl. 30, figs. 5, a, b.

Goniobasis chrysalloidea White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 462, pl. 6, figs. 11, 12.

Shell of medium size, gradually tapering from the last volution to the apex; volutions about seven or eight, those of the spire slightly convex, the last one broadly rounded to the anterior end; suture impressed, the apparent impression being increased by the projecting fold of the distal border of each volution, which is appressed against the next preceding one. Surface marked by more or less distinct longitudinal, slightly bent ridges or varices, which are crossed by several revolving lines that appear only on the ridges, and not between them, giving the ridges a knotted or crenulated appearance; anterior surface of the last volution also marked by distinct raised revolving lines.

Length of the most perfect of the original type specimens, 28^{mm}; diameter of the last volution, 9^{mm}; but some specimens since obtained are somewhat more slender.

This species is closely related to both *G. cleburni* and *G. chrysalis*, with both of which forms it is associated. It differs from the latter in its much larger size, much greater apical angle, straighter sides of the

spire, and in the details of its ornamentation. It differs from *G. cleburni* in its smaller size, the more distinct crenulation of its longitudinal varices or folds, and in possessing the revolving fold-like projection of the distal border of its volutions which has been mentioned in the description.

The locality at the mouth of Sulphur Creek and the one 7 miles north of Evanston are the only localities that have yet furnished recognized specimens of this species, and all of the specimens are in an imperfect condition.

PACHYMELANIA TURRICULA n. s.

Plate VII, figs. 14, 15.

Shell rather small and slender; apex acute; sides of the spire nearly straight; volutions of the spire moderately convex and marked by numerous longitudinal varices which have a tendency to range themselves in continuous lines; the ends of the varices of the one volution not quite reaching those of the next preceding and succeeding volutions gives the shell the appearance of having an unusually deep suture; the anterior volutions of the spire are marked by four depressed revolving lines, giving the varices a crenulated appearance, but these lines are obsolete or absent on the smaller volutions. The surface of the anterior part of the last volution is marked by four or five raised revolving lines, which diminish in strength toward the axis.

The largest and best specimen discovered is imperfect at the proximal end, and its full length is therefore unknown; it probably reached a length of 16^{mm} and a diameter of 6^{mm} at the last volution. This form somewhat resembles the young of *P. cleburni*, but it differs conspicuously in having a smaller apical angle and in having its sides straight along its entire length. Its longitudinal varices are also much more generally disposed in continuous lines.

Mr. Stanton obtained this species at the locality near the mouth of Sulphur Creek and at the one near Sage Station.

There are many specimens referable to *Pachymelania* in the collections obtained from the Bear River formation, mostly small examples, which one finds it difficult to assign to any of the species just described because of the recognizable interspecific variation in the case of all of them. This fact, together with the remarkable variation of the associated *Pyrgulifera humerosa* which is to be pointed out on following pages, suggests the possibility that some of the forms of *Pachymelania* just described are only varieties of some of the others, but so far as these forms are now known they all seem to be worthy of full specific recognition. One of the varieties referred to, found by Mr. Stanton at the locality near Sage Station, in the valley of Twin Creek, probably represents a variety of *P. chrysalis*, but the specimens are so constant in their characteristic differences from that form that I have hesitated to refer them to it. This variety is well represented by figs. 12 and 13, on Pl. VII.

PACHYMELANIA? MACILENTA White.

Plate VII, fig 9. Compare also with 10, 11.

Goniobasis macilenta White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 93, pl. 30, figs. 10, a.

Goniobasis macilenta White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 462, pl. 6, fig. 12.

Shell comparatively small, slender; test thinner than is usual with typical species of *Pachymelania*; sides of the spire straight or slightly concave; volutions ten or more in number, uniformly increasing in size, the distal border of each so appressed against the next preceding one that their flattened sides form the continuous surface of the straight sides of the shell. Surface marked by the linear suture and by lines of growth which are gently sinuous and have a general direction approximately corresponding to the axis of the shell. Near the distal border of each volution there is usually to be observed in well-preserved examples a more or less distinct revolving impressed line which simulates a second suture.

Numerous examples of this species have been discovered, but they are all more or less broken and imperfectly preserved. The shape of the aperture is therefore known only by the outline of the volutions and the direction and character of the lines of growth which are observable upon the volutions. All of these characters are consistent with those which distinguish *Pachymelania*.

Most of the specimens discovered are small, the largest indicating that adult examples reached a length of 25^{mm} and a diameter of 7^{mm} for the last volution. The principal reason for doubt that this shell belongs to *Pachymelania* is the comparative thinness of the test. In this respect it more nearly resembles *Goniobasis*, to which genus I have hitherto referred it. A chalcedonic pseudomorph of a young shell which I refer to this species shows that the minute apical volutions were distinctly convex, but that they became flattened before the shell had reached a millimeter in length. The columella of this example, not being distinctly arcuate, suggests its relation to *Eulimella*, but there is no indication of a reversal, or even of distortion, of the apical volutions. It is probable that figs. 10 and 11 on Pl. VII represent another species, but I am not now able to satisfactorily diagnose them as specifically different from *P. ? macilenta*.

This species was first discovered at the locality near the mouth of Sulphur Creek, but it has since been found at most of the localities which have furnished fossils of the Bear River fauna. It therefore appears to have as great a geographical distribution as has any other member of that fauna.

Genus PYRGULIFERA Meek.

This genus has been the subject of so much discussion and the only known American representatives of it are so characteristic of the Bear River formation that it is thought advisable to give Mr. Meek's generic diagnosis here and to discuss the genus and its geographical distribution and chronological range more at length on following pages. The following is the diagnosis as published by Mr. Meek in Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel, page 176, but it requires some modification to admit certain forms since properly referred to this genus; such, for example, as those upon which the shouldering of the volutions and the strong surface features mentioned by Mr. Meek are not well developed:

Shell subovate, thick, imperforate; spire produced, turreted; volutions angular, shouldered, and nodular above; surface typically, with vertical ridges and revolving markings; aperture subovate, faintly sinuous, but not notched or distinctly angular below; outer lip prominent in outline below the middle, retreating at the base, and subsinuous at the termination of the shoulder of the body-volution above; peristome continuous; inner lip a little callous below, and thickened all the way up, but without a protuberant callus above, sometimes with a shallow umbilical furrow along its outer margin below.

With the single exception to be mentioned further on, neither this nor any nearly related genus is yet known in North America beyond the limits of the Bear River formation. All the other known species of Pyrgulifera are mentioned on following pages under the general head of "The geographical and time range of Pyrgulifera."

PYRGULIFERA HUMEROSA Meek.

Plate VIII, figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and Plate IX, figs. 4, 5, 6, 7, 8.

Melania humerosa Meek, 1860, Proc. Acad. Sci. Phila., Vol. XII, p. 313.

Pyrgulifera humerosa Meek, 1872, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1871, p. 376 (no description).

Pyrgulifera humerosa Meek, 1876, Simpson's Rept. Great Basin of Utah, p. 363, pl. 5, figs. 6, a, b, c.

Pyrgulifera humerosa Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 176, pl. 17, figs. 19, 19a, and woodcut.

Pyrgulifera humerosa White, 1882, Nature, Vol. XXV, p. 101.

Pyrgulifera humerosa White, 1882, Proc. U. S. Nat. Museum, Vol. V, p. 98, pl. 3, figs. 10, 11, 12.

Pyrgulifera humerosa White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 460, pl. 6, figs. 4, 5, 6.

Pyrgulifera humerosa Tausch, 1884, Sitzungsber. K. Akad. Wiss., Band XC, p. 60, Pl. I, figs. 1-3.

Pyrgulifera humerosa White, 1885, Am. Jour. Sci., Vol. XXIX (2), p. 278.

Pyrgulifera humerosa Tausch, 1886, Abhandl. K.-k. geol. Reichsanstalt, Band XII, p. 4.

The following is the specific description published by Mr. Meek on pages 176-177 of Vol. IV of the reports of the United States Geological Exploration of the Fortieth Parallel:

Shell attaining a rather large size, moderately solid, ovate-subfusiform; spire prominent, distinctly turreted; volutions five and a half to about seven, angular and strongly shouldered, the upper surface being flattened or a little concave, with usually a slight outward slope from the suture to the angle or shoulder, where it meets the vertical outer surface nearly at right angles; last or body-volution large, or generally composing about two-thirds the entire bulk and length of the shell; suture well defined by the prominence and angularity of the volutions, but not channeled. Surface of each turn ornamented by about ten to fifteen rather strong, vertical, or slightly oblique folds, or costæ, each of which terminates in a small, nodular projection at the shoulder above, so as sometimes to impart a subcoronate appearance to the same, while they all become nearly or quite obsolete below the middle of the body-volution; vertical costæ crossed by smaller, but quite distinct revolving, raised lines, or small ridges, some four to six of which may be counted on the outer surface of each turn of the spire, and about ten on the body-volution, where they increase in size downward; upper flattened surface of the volutions generally only marked by the moderately distinct lines of growth seen below; aperture obliquely rhombic-subovate, being higher than wide, rounded subrectangular above, and narrowed and more or less angular, with a slight sinus or notch at the connection of the outer and inner lips near the middle below; columella arcuate; inner lip, in mature specimens, rather thick all the way up, but more so below, where it is somewhat reflected and margined by a slight, revolving, umbilical furrow, with usually an angular outer margin; outer lip sharp, prominent near the middle, and retreating below and at the angle of the whorls above.

The length of Mr. Meek's principal type specimen, which is one of the largest yet discovered, is 41^{mm}; breadth of its last volution, 23^{mm}. There is, however, much difference in size and proportions among the multitude of specimens that have been collected.

Mr. Meek's description applies completely to his type specimen and to much the greater part of the many hundreds of specimens which have been discovered in the Bear River formation. A few of these, however, show such variations of form and ornamentation that no one would hesitate to assign them to different species if they were not associated with intermediate forms and by them more or less closely connected with the great mass of typical forms. Figs. 1 to 10 on Pl. VIII represent what may be regarded as typical forms, and figs. 4 to 8 on Pl. IX represent some of the varieties referred to.

The greatest amount of variation that has been observed is found among the specimens collected by Mr. Stanton at the Cokeville locality, where most of the specimens figured on Pl. IX which show material variation were obtained. The variation consists mainly in the modification of surface features and ornamentation, but there is also some variation of general shape. The coincidence of the two kinds of variation is, however, only exceptional.

Figs. 1, 2, and 3 on Pl. IX represent a form which differs so much from all the others that I have thought it expedient to give it the separate specific name which heads the following description. I do this more as a matter of convenience than because of any belief that there

is in the Bear River formation more than one true species of *Pyrgulifera*. That is, it is evident that all the varieties just referred to, including the one last mentioned as well as the typical forms of *P. humerosa*, were intimately associated with one another while living; and I think it is also evident that they all freely interbred. If this was the case, each form was not only potentially but actually ancestral to representatives of all the other forms, and therefore, according to my understanding of the character and limitation of a species, all these forms are properly included in one specific group.

No member of the Bear River fauna is more conspicuous than is *Pyrgulifera humerosa*. Its geographical distribution is throughout the known extent of the formation, but it has been found especially abundant at the locality near the mouth of Sulphur Creek and at the one 7 miles north of Evanston, in southwestern Wyoming.

PYRGULIFERA STANTONI n. s.

Plate IX, figs. 1, 2, 3.

Among the specimens obtained at the Cokeville locality by Mr. Stanton are some examples of *Pyrgulifera* which have already been referred to as differing so much from typical forms of *P. humerosa* that I think it expedient for geological, but not necessarily for biological, purposes to give them a separate name. The principal difference between these specimens and typical examples of *P. humerosa* is their greater elongation, less distinct shouldering of the volutions, the somewhat greater prominence of the longitudinal varices, and less distinctness of the revolving lines. Typical examples of *P. humerosa*, as well as the other varieties referred to in connection with the description of that species, were found associated in the same layers with this form, and few examples have been discovered which may be regarded as intermediate between them.

The type specimens of *P. stantoni* are represented by figs. 1 and 2. Fig. 3 represents a form which, while it is here referred to *P. stantoni*, seems to be intermediate between them and the more elongate examples of *P. humerosa*.

Family RISSOIDÆ.

Genus HYDROBIA Hartmann.

HYDROBIA OCCULTA n. s.

Plate X, figs. 12, 13.

Shell very small, elongate, minutely perforate at the base; apex slightly obtuse; volutions six or seven in number, rounded, those of the anterior half of the shell a little more oblique to its axis than are those of the posterior half; suture impressed; aperture subovate, extended in front by the obliquity of the last volution. Surface marked only by lines of growth.

Length, 3^{mm}; breadth of last volution, 1^{mm}.

Several examples of this little shell, like those of several of the other species which are described in this bulletin, were discovered in the condition of chalcedonic pseudomorphs among the débris resulting from an acid solution of fragments of impure limestone found by Mr. Stanton at the locality 20 miles north of Cokeville. It seems to be properly referable to *Hydrobia*, but the apical angle of the spire is less than is usual with species of that genus, and the apex is also a little more obtuse.

Genus BYTHINELLA Moquin-Tandon.

BYTHINELLA LATENTIS n. s.

Plate X, figs. 10, 11.

Shell very small, moderately elongate, its sides gently convex, base imperforate; volutions five in number, convex; suture impressed; surface marked only by lines of growth; aperture not much expanded, subcircular or suboval in outline, obtusely angular posteriorly.

Length, hardly reaching 3^{mm}; diameter of the last volution, 1^{mm}, or a little less.

This little shell was found associated with the preceding species, and was obtained from its embedding limestone matrix in the same manner. It has been found at no other locality than the one 20 miles north of Cokeville, and if they had not been changed from their original condition to that of chalcedonic pseudomorphs it is not likely that they would ever have been discovered.

Genus CHARYDROBIA Stache.

CHARYDROBIA STACHEI n. s.

Plate X, figs. 7, 8, 9.

Shell large for a species of this genus, subfusiform; volutions about six in number, regularly convex; aperture subovate in outline, narrowly rounded in front, narrow and subangular behind; umbilical fissure more or less distinct. Surface plain.

Length of the largest example discovered, 13^{mm}; breadth of the last volution of the same, 6½^{mm}.

Specimens of this shell, like those of several others already described, were obtained in the condition of chalcedonic pseudomorphs by dissolving in acid the fragments of impure limestone in which they were imbedded. This form has been by some collectors confounded with *Limnæa nitidula*, but it is distinctly different from that species, and there seems to be no good reason to doubt that it is properly referable to the genus *Charydrobia* Stache. Indeed it bears a close resemblance to the type of that genus, *C. characearum*, as figured by Stache on Pl. V, Abhandlungen der K.-k. geologischen Reichsanstalt, Band XIII.

This species has been found only at the locality near the mouth of Sulphur Creek and at the one 20 miles north of Cokeville. It is probable, however, that it had a general distribution in the Bear River formation.

Family VIVIPARIDÆ.

Genus VIVIPARUS Montfort.

VIVIPARUS COUESI White.

Plate X, fig. 1.

Campeloma ———? Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 181, pl. 17, figs. 15, 15a.

Viviparus couesi White, 1878, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. IV, p. 717.

Viviparus couesi White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 99, pl. 30, fig. 1, a.

Viviparus couesi White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 467, pl. 8, fig. 1.

Shell very large when fully adult; volutions six or seven, convex, the distal side, of the last one especially, abruptly rounded to the suture, giving it a somewhat shouldered aspect there, while the outer side is broadly convex and sloping gently forward and inward; suture deeply impressed, the apparent depth being increased by the great convexity of the volutions. Surface marked by the ordinary lines of growth, no revolving marks of any kind having been detected. The lines of growth indicate that the margin of the outer lip is nearly straight, as is usual with all species of this genus, this feature being one of those which distinguish shells of this genus from those of *Campeloma*. Inner lip somewhat thickened by callous and reflexed at the proximal or anterior end, but not covering the umbilical fissure there, which is moderately large. The precise shape of the aperture is unknown, but the outline of the volutions shows that it was subovate.

No perfect examples have been discovered, but the largest one yet obtained would, if perfect, measure about 65^{mm} in length; full width of body volution, 38^{mm}.

The apical portion of a specimen of this species was described and figured (loc. cit.) by Mr. Meek under the generic name of *Campeloma*, but he gave it no specific name. His specimen, however, like the type specimen figured on Pl. X, shows by its nonsinuuous lines of growth that it had the straight outer lip of *Viviparus* and not a sinuous one like *Campeloma*.

Mr. Meek's specimen came from the locality near the mouth of Sulphur Creek. The type specimen figured on Pl. X came from the locality 7 miles north of Evanston. The species has not been certainly identified at any other locality.

Genus CAMPELOMA Rafinesque.

CAMPELOMA MACROSPIRA Meek.

Plate X, figs. 2, 3.

Melantho (*Campeloma*) *macrospira* Meek, 1873, Ann. Rept. U. S. Geol. and Geog. Surv. Terr. for 1872, p. 478.

Campeloma macrospira Meek, 1877, U. S. Geol. Explor. Fortieth Parallel, Vol. IV, p. 179, pl. 17, figs. 17, a, b.

Campeloma macrospira White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 102, pl. 30, figs. 2, a.

Campeloma macrospira White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 469, pl. 8, figs. 6, 7.

The following is Mr. Meek's description of this form as published by him in 1877 (loc. cit.):

Shell ovate, of medium size; volutions about five or six, convex, increasing rather gradually in size and without revolving ridges or angularities; spire moderately prominent, conical, and not eroded at the apex; suture distinct, in consequence of the convexity of the volutions; surface with fine, obscure, slightly sigmoid lines of growth; aperture ovate; inner lip somewhat thickened below.

The length of Mr. Meek's type specimen, which is figured on Pl. X, is 44^{mm}; breadth of the last volution of the same, 28^{mm}.

Specimens of this species have been found at most of the localities at which the Bear River formation has been recognized, and its geographical distribution was apparently equal to that of the formation.

Genus LIOPLAX Troschel.

LIOPLAX? ENDLICH White.

Plate X, figs. 4, 5.

Goniobasis endlichi White, 1878, Bull. U. S. Geol. and Geog. Surv. Terr., Vol. IV, p. 716.

Goniobasis endlichi White, 1880, Twelfth Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 92, pl. 30, figs. 7, a, b, c.

Goniobasis (*Lioplax*?) *endlichi* White, 1883, Third Ann. Rept. U. S. Geol. Surv., p. 463, pl. 7, figs. 7, 8.

Shell moderately elongate-conical, sides of the spire straight, or slightly concave; volutions six or seven in number, convex, the larger ones showing an obsolete angularity at the middle; suture well defined and appearing unusually deep, because of the prominent convexity of the volutions; aperture subovate in outline, its distal end angular, its front somewhat narrowly rounded; outer lip apparently sharp; inner lip with a thin reflected callus which is more developed anteriorly than posteriorly. Surface marked by fine distinct lines, which give it a cancellated appearance under a lens. A few of the revolving lines are stronger than the others, and these are observable without the aid of a lens.

Length, about 22^{mm}; diameter of the last volution, 11^{mm}.

This form has been found only at the locality 7 miles north of Evans-ton, Wyo. It was evidently not an abundant species, but it is distinctly different from any other recognized member of the Bear River fauna. There is, however, reason to doubt that the extent of variation to which the surface markings were subject were as great as has been indicated in former publications. The foregoing description may therefore be regarded as applying only to the specimens which are represented on Pl. X by figs. 4 and 5. Two imperfect examples were found associated with those which in the publication quoted at the head of this description I have referred to this species and figured in connection with the others, but I am not quite satisfied as to their specific identity with *Lioplax? endlichi*. One of these doubtful specimens is represented by fig. 6. The revolving raised lines upon these doubtful specimens are much stronger than they are upon the typical examples, but the fine revolving and longitudinal lines the presence of which the lens reveals are of the same character in both cases. This fact makes me hesitate to separate them under different specific names, although I think it possible that this may be made necessary by future discoveries.

This species is evidently referable to the family Viviparidæ, and its sinuous outer lip suggests its affinity with *Campeloma*, but in the sub-angular character of its volutions and the presence of revolving markings, as well as in general aspect, it resembles the *Lioplax subcarinata* of Say, a species now living in North American fluviatile waters. These features have suggested its reference to that genus, although nothing is known of its most distinctive shell feature, the structure of the operculum.

MOLLUSCOIDEA.

It is hardly to be expected that the Molluscoida would be represented in a nonmarine fauna like that of the Bear River formation, but some traces of a Bryozoan form have been found attached to shells of *Corbula pyriformis* which were obtained at the Sulphur Creek locality. They are too imperfect for description, or even for satisfactory determination, but they probably belong to the genus *Membranipora* of Blainville.

ANNULOSA.

CRUSTACEA.

The residue resulting from an acid solution of the pieces of impure limestone which were obtained by Mr. Stanton from near Cokeville, Wyo., and which have been already several times mentioned in connection with the foregoing descriptions, was found to contain numerous specimens of silicified shells of Ostracoda. A quantity of this residue was sent for examination to Prof. T. Rupert Jones, of London, whose exhaustive studies of these minute crustaceans are everywhere known, and he found it to contain an unexpectedly large number of forms.

These proved to be of so much interest that he has published an illustrated article concerning them in the London Geological Magazine.¹

In this collection of Bear River Ostracoda Professor Jones has recognized twelve species and seven genera, of which the following is a list:

<i>Cypris purbeckensis</i> E. Forbes.	<i>M. simplex</i> n. s.
<i>Cypridea tuberculata</i> Sowerby,	<i>Cythere monticula</i> n. s.
var. <i>wyomingensis</i> .	<i>Cytheridea truncata</i> n. s.
<i>Potamocypris affinis</i> , n. s.	<i>C. tenuis</i> n. s.
<i>Matacypris consobrina</i> n. s.	<i>Cytherideis æqualis</i> n. s.
<i>M. subcordata</i> n. s.	<i>C. impressa</i> n. s.
<i>M. cuneiformis</i> n. s.	

The unusually large number of both genera and species thus represented and the wide geographical and considerable chronological range assigned to some of them by Professor Jones make it desirable that all the recognized forms of this Bear River Ostracoda fauna should be represented in this bulletin. They are therefore all figured on Pl. XI, the figures all being copies from Professor Jones's original publication, but it is not thought necessary to republish specific descriptions of the several forms.

It will be seen by the foregoing list that all except two of these forms are described by Professor Jones as new. One of these two he regards as a variety of *Cypridea tuberculata* Sowerby, and the other as identical with *Cypris purbeckensis* E. Forbes, both species having been originally described from the Purbeck division of the English Jurassic. It is an interesting fact that the fresh-water Jurassic fauna of Colorado² contains a species of *Cypris* which Professor Jones refers doubtfully to *C. purbeckensis*, and that *Metacypris consobrina* and *M. subovata* of the Bear River fauna are closely related to *M. forbesii* as it occurs in the Colorado Jurassic. Others of these Bear River Ostracoda, however, are related to members of later faunas.

Professor Jones observes that nearly all these Bear River Ostracoda represent either fresh-water or estuarine forms, but that two or three of them represent marine forms. This fact is not really discordant with the nonmarine character of the associated mollusca. Some of the species of the latter class have living representatives which are capable of thriving in waters of full marine saltness as well as in those which are much less saline, and it is not unreasonable to suppose that those Ostracoda were capable of thriving under similar differences of condition of habitat.

PLANT REMAINS.

Certain of the Bear River strata contain an admixture of much carbonaceous matter, and in some of them impure lignite has been found. This matter having been of vegetal origin, it is presumable that an abundant flora existed contemporaneously with the deposition of the

¹ See Geol. Mag., new ser., Decade III, Vol. X, pp. 385-391, pl. xv, London, 1893.

² See Bull. U. S. Geol. Surv. No. 29, p. 24, 1886.

formation, but it is nevertheless true that plant remains in a classifiable condition are extremely rare in its strata. The only remains of this kind yet discovered are some minute Chara fruits and the few fragmentary imprints of dicotyledonous leaves which are mentioned on page 22. Although the latter are too imperfect for satisfactory description and illustration, there can be no question of their dicotyledonous character, nor can there be any doubt that they represent an abundant flora. The Chara fruits have been studied and published by Prof. F. H. Knowlton,¹ the following being a copy of his description:

CHARA STANTONI Knowlton.

Plate X, figs. 14, 15, 16.

"Fruit (Sporostegium), oblong-elliptical in general outline, slightly smaller at the apex, obtuse, nearly one-fifth longer than wide; length, 0.63^{mm}; diameter, 0.48^{mm}. Number of spirals as observed in side view, eight or nine; cells furrowed, separated by thin, low, projecting ridges."

BIOLOGICAL DISCUSSION.

The existence of remains of great vertebrate faunas during all the other known epochs of the Mesozoic era makes it certain that important faunas of that kind existed contemporaneously with the deposition of the Bear River formation. Indeed, that such a fauna existed in the immediate vicinity of, and in part within, the body of water in which its deposition took place may be legitimately inferred, but up to the present time no vertebrate remains are known to have been discovered in any strata that are certainly referable to this formation. Therefore all further reference to a vertebrate fauna must be omitted from a biological discussion of the Bear River formation on this occasion.

That an abundant flora, mainly dicotyledonous, existed during the Dakota epoch is well known, and if, as the evidence now seems to indicate, the Dakota epoch preceded the Bear River epoch, we may assume that an equally important flora existed while the Bear River formation was in process of deposition. Indeed such an assumption would be hardly less rational if it should yet appear that the Bear River is older than the Dakota formation. Still, we have only the indefinite evidence of the existence of a Bear River flora that has been mentioned on a preceding page. That is, besides the comparatively large amount of carbonaceous matter which certain of the Bear River strata contain, all the plant remains yet discovered in any of them are a few fragmentary imprints of leaves and a few Chara fruits. Therefore, while we can not doubt that a great and varied flora existed during the Bear River epoch, and within the Bear River district, we can not now discuss its existence as an ascertained biological fact.

¹Botanical Gazette, Vol. XVIII, pp. 141-142, Bloomington, Ind., 1893.

This necessary exclusion of vertebrates and plants leaves only the invertebrate fauna to be considered in a biological discussion of the Bear River formation. This invertebrate fauna, so far as it is yet known, is represented concisely by the following classified list of the species, all of which are described and figured on the plates accompanying this bulletin:

The invertebrate fauna of the Bear River formation.

MOLLUSCA.

CONCHIFERA.

Family OSTREIDÆ.

Genus OSTREA Linnæus.

Ostrea haydeni White.

Family MYTILIDÆ.

Genus MODIOLA Lamarck.

Modiola pealei W.

Family UNIONIDÆ.

Genus UNIO Retzius.

Unio belliplicatus Meek.

U. vetustus M.

Family CYRENIDÆ.

Genus CORBICULA Megerle.

Corbicula durkeei M.

Family CORBULIDÆ.

Genus CORBULA Bruguiere.

Corbula pyriformis M.

C. engelmanni M.

Genus CORBULOMYA Nyst.

Corbulomya tauschii W.

GASTEROPODA.

Family AURICULIDÆ.

Genus AURICULA Lamarck.

Auricula neumayri W.

Genus MELAMPUS Montfort.

Melampus clarkii W.

Genus RHYTOPHORUS Meek.

Rhytophorus priscus M.

R. meekii W.

Genus TORTACELLA White.

Tortacella haldemani W.

Family LIMNÆIDÆ.

Genus LIMNÆA Lamarck.

Limnæa nitidula M.

Genus PLANORBIS Müller.

Planorbis (Gyraulus) præcursoris W.

Family PHYSIDÆ.

Genus PHYSA Draparnaud.

Physa usitata W.

Family HELICIDÆ.

Genus HELIX Linnæus.

Helix? ———?

Genus TORNATELLINA Beck.

Tornatellina? isoclina White.

Family NERITIDÆ.

Genus NERITINA Lamarek.

Neritina naticiformis W.

N. stantoni W.

Family MELANIIDÆ.

Genus PACHYMELANIA White.

Pachymelania cleburni W.

P. chrysalis Meek.

P. chrysalloidea W.

P. turricula W.

P? macilenta W.

Genus PYRGULIFERA Meek.

Pyrgulifera humerosa Meek.

P. stantoni W.

Family RISSOIDÆ.

Genus HYDROBIA Hartmann.

Hydrobia occulta White.

Genus BYTHINELLA Moquin-Tandon.

Bythinella latentis W.

Genus CHARYDROBIA Stache.

Charydrobia stachei W.

Family VIVIPARIDÆ.

Genus VIVIPARUS Montfort.

Viviparus couesi W.

Genus CAMPELOMA Rafinesque.

Campeloma macrospira M.

Genus LIOPLAX Troschel.

Lioplax? endlichi W.

MOLLUSCOIDEA.

Genus MEMBRANIPORA Blainville.

Membranipora? ———?

ANNULOSA.

CRUSTACEA.¹

When one finds it necessary to compare different fossil faunas with one another, it is desirable to know as definitely as practicable whether in each case the fauna is a full one; in other words, it is desirable to know whether all the forms of which a given fauna under investigation was originally composed are probably represented by discovered fossil remains. It has just been shown that the Bear River fauna includes no known vertebrates, and the foregoing list shows that, with the

¹ See the list of the Bear River Ostracoda on page 62.

exception of the Ostracoda just mentioned, its known invertebrate fauna consists wholly of mollusca.

Examining this list with reference to the known general character and composition of living faunas, we do not observe any necessarily material discrepancy among the branchiferous forms, nor any among those of either the littoral or the palustral pulmoniferous forms; that is, these divisions of the mollusca are often no more fully represented among living nonmarine faunas than they are in the foregoing list. There are, however, no specimens among all the collections that have yet been made from the Bear River strata which can with entire confidence be referred to the land pulmoniferous mollusca, and only two species have been discovered which are provisionally so referred.

It should be borne in mind, in this connection, that remains of land mollusca can reach sedimentary entombment only by accidental transportation, while remains of aquatic mollusca have generally been entombed where they lived. Therefore it is probable that the land mollusca were well represented in the district surrounding the waters in which the Bear River formation was deposited. Still, the forementioned discrepancy among the collections of Bear River fossils exists, and it will be further referred to or indicated in following discussions. It will also in part be shown by a comparison of the foregoing list with the lists of other faunas which are given on following pages.

The foregoing statements make it apparent that in discussing the fauna of the Bear River formation we are not only practically confined to the mollusca, but we are confined to a certain few families. Furthermore, applying the accepted criteria of past aqueous conditions, we find that all these molluscan forms fall into the nonmarine category; that is, they are forms the living congeners of which are denizens of either brackish water or fresh water or of the land, there being no representatives among them of forms that now live exclusively in marine waters.

It is clearly apparent, from an examination of the important and somewhat numerous collections of the Bear River molluscan fossils which have been brought to the National Museum, that forms which represent all the varieties of habitat just referred to, including remains of both branchiferous and pulmoniferous mollusca, are intimately commingled in at least a part of the Bear River strata. This fact is especially apparent to the geologist who has himself collected the fossils of that formation. The collector of fossils from the Bear River formation also observes that the layers which contain *Ostrea haydeni* contain comparatively few other forms, and that such purely fresh-water forms as *Unio*, *Viviparus*, etc., are rarely, if ever, commingled with them. It is true, however, that some of the forms which are found in intimate association with the *Ostrea* are also found in similar association with those which we call purely fresh-water forms; but this is taken to indicate that the associate forms referred to were capable of thriving

in both saline and fresh waters, while the *Ostrea* could exist only in saline waters, and the *Unio*, *Viviparus*, etc., only in fresh waters.¹

This apparently, and in part really, incongruous commingling of the fossil remains which constitute the Bear River molluscan fauna is of special interest in connection with its study, and the probable causes of it have also a general relation to the possible geographical dispersion of specific and generic molluscan forms, which subject also will in part be discussed on following pages.

The remarks which I propose to make upon both these subjects will be better understood by some explanatory references to certain of the principles and criteria upon which they are based and which are tacitly understood by geologists, although they are rarely enunciated in their writings.

In discussing the evidence of past aqueous conditions, which by comparison with present conditions are known to have attended the production of the various sedimentary formations of the earth, it has become customary among geologists to apply the term nonmarine to those bodies of water which are either fresh or less saline than are the oceans and the seas which directly and freely communicate with them. It has also become customary to apply the same term to the fossil faunas which present inherent evidence of having existed in such bodies of water, as well as to the formations which were deposited in them. In some cases the entire aquatic fauna whose remains are found to characterize a given nonmarine formation is composed of such forms as plainly indicate that the waters in which they lived and in which that formation was deposited were wholly fresh. In other cases the fossil remains indicate that the waters were more or less saline, and in still others there is a commingling, or an association, of forms which are properly regarded as characteristic of fresh and saline waters, respectively. Reference is here made especially to the mollusca, because it is with the remains of those animals more than with remains of any others that the geologist has to deal in his investigations of the distinguishing characteristics of nonmarine formations.

The remarks here offered are also restricted to such nonmarine deposits as have been laid down in more or less broad bodies of water, those which may have been deposited in fluviatile waters not being at present considered. A large proportion of the now living denizens of fresh waters inhabit rivers and streams, and such was doubtless the case in former geological epochs; but fluviatile deposits are so extremely rare among geological formations that little reference need be made to them in discussing those of nonmarine origin.

In the case of formations which are unhesitatingly referred to a fresh-water origin all the contained fossil remains of branchiferous mollusca

¹ The frequent association of specimens of *Pyrgulifera* and *Pachymelania* with *Ostrea haydeni* suggests that these Melanians lived congenially with the *Ostrea*. A similar association of *Melania* with *Ostrea* and *Anomia* has been observed in the Laramie formation.

are those which pertained to forms whose living congeners are incapable of thriving in waters containing an appreciable amount of salt; but among the faunas of other nonmarine formations there is usually a greater or less number of forms whose living congeners are capable of adapting themselves to both brackish and fresh waters. Furthermore, certain forms, such as *Ostrea* and *Anomia*, for example, are not unfrequently found among nonmarine faunas, although all known living members of these families are, and doubtless all their members always have been, incapable of permanent existence in waters which do not contain an appreciable amount of salt, while they are capable of thriving as well in waters of full marine saltiness as they are in brackish waters.

It is the branchiferous mollusca that have been particularly referred to in the preceding paragraphs. These, of course, require constant aqueous submergence, and, as a rule, their remains were immediately entombed in the sediments of the waters in which they lived, those sediments having constituted the strata in which their remains are found. It is usually the case, however, that a nonmarine fossil fauna contains a greater or less proportion of the remains of pulmoniferous mollusca, including those of terrestrial, as well as those of littoral and palustral, habitat. Fossil remains of all, or a part, of these three kinds of pulmoniferous mollusca are so generally found commingled with those of the various kinds of branchiferous mollusca that, as a rule, one expects to find more or less of such remains in every nonmarine formation.

The littoral pulmoniferous mollusca here referred to are such forms as the *Auriculidæ*, for example, which live in the shallows, or within reach of the spray, of saline waters only, and it is a significant fact that fossil congeners of these mollusca have been found only in association with other evidence than that afforded by the structure of their shells that the deposits containing them were, at least in part, laid down in brackish waters. Those referred to as palustral pulmoniferous mollusca are such forms as the *Physidæ* and *Limnæidæ*, for example, which live in the shallow fresh waters of ponds and marshy shores. No explanation as to the conditions of habitat of land mollusca is deemed necessary, but it may be remarked that the sedimentary entombment of their remains was always more or less accidental.

Applying these general statements to the Bear River formation, we do it with reference to that commingling of remains of fresh-water and brackish-water branchiferous, and of littoral and palustral pulmoniferous, mollusca which has just been referred to and which was more definitely stated in a previous paragraph. The very large proportion of the members of the Bear River molluscan fauna, which indicates a brackish-water habitat, and the general distribution of those forms throughout the whole formation, leave no room for reasonable doubt that it was deposited in a brackish-water lake or sea which was more

or less completely cut off from open marine waters. One therefore naturally desires to inquire what were the conditions under which the commingling was accomplished.

Such an inquiry is appropriate not only in the case of the Bear River formation, but equally so in the case of many other nonmarine formations, as may readily be seen by the commingling of fresh-water and brackish-water forms in their respective fossil faunas. The great Laramie formation, with which the Bear River formation was formerly confounded, presents a case of this kind which is all the more remarkable because of the great geographical extent of the area which it occupies. Unfortunately, however, our present knowledge of the subject is so meager that such an inquiry can result in little more than a few suggestions.

Such a commingling of molluscan remains as is observed in the case of the Bear River fauna may imply, first, that they were accidentally brought together; second, that the species which they represent lived together in one and the same congenial habitat; or, third, that fresh and brackish waters periodically alternated upon certain portions of the great aqueous area within which the formation was deposited.

We may, as already intimated, properly assume that many of these Bear River species were capable of living in waters of varying degrees of saltness, and therefore that a large proportion of the whole fauna lived and thrived together, and consequently that their remains were entombed together. We may also assume that by the action of winds, or of inflowing or other currents, the shells of pulmoniferous mollusca were frequently drifted out into the open waters, where they sank and became intombed among the shells of gill-bearing forms.

We can not, however, assume that such branchiferous forms as *Ostrea haydeni* on the one hand and *Unio belliplicatus*, *U. vetustus*, and *Viviparus couesii* on the other were capable of living and thriving together. Therefore any promiscuous commingling of such categories of forms as these must have been accidental, but we must assume that their respective prevalence in alternating layers has been the result of alternation of saline and fresh waters—that is, an alternation of congenial conditions for each—within certain portions of the great aqueous area in which the formation was deposited.

If there were any evidence that the shells of the fresh-water branchiferous members of the Bear River fauna were drifted to the places of their entombment, the question as to the cause of their commingling with the brackish-water forms would be a simple one, but these shells are too heavy to have been drifted by any current that would not have produced in the sedimentary deposits ample evidence of its action, and no such evidence has yet been discovered. Moreover, the conditions of their entombment and preservation, together with their general distribution throughout the formation, present as good evidence that the mollusca which they represent lived and died where their remains are found as there is in the case of the brackish-water forms.

The general character of the Bear River molluscan fauna indicates that the average saltness of the body of water in which it lived, although variable in different parts, as already mentioned, was practically the same from the beginning to the end of the epoch. A supply of fresh water to the Bear River sea of course came from surface drainage, but what was the source of its supply of salt and how that general average was maintained we can only conjecture. It may have been that a sufficient amount of salt was retained from the marine waters which prevailed over the same area during the preceding epoch, and that this was sufficiently supplemented by surface drainage and evaporation to balance the loss by outflow, or it may have been that supplies of salt came by periodical incursion of waters from an adjacent marine area; but we have no conclusive evidence on any of these points.

That there were the numerous alternations of fresh and saline areas in various parts of the Bear River sea which have been mentioned, and that these alternations occurred at intervals during the whole epoch of its existence, is sufficiently obvious. The long duration of that epoch is indicated by the aggregate thickness of the Bear River formation, which is about 3,000 feet. It is also obvious that the influx of river freshets is not sufficient to explain these alternations of fresh with brackish waters, because in the strata containing the fresh-water forms there are no sufficient physical indications that such freshets occurred. Besides this, the condition of those fossils and of the strata in which they occur is such as to indicate that a fresh-water fauna became established in certain parts of the Bear River sea and thrived there until the congeniality of its habitat was destroyed or it was shifted to other parts by the afflux of saline water. It is natural to infer that the main portion of such a body of water as was the Bear River sea was at all times too saline for fresh-water mollusks to thrive in, and to assume that such mollusks found a congenial habitat only along certain portions of its borders.¹

Such a shifting of conditions of habitat as has just been mentioned was necessarily due to shifting physical conditions, chief among which were probably changes in the surrounding drainage system and in the bottom and shore-line of the Bear River sea.

THE BEAR RIVER FAUNA COMPARED WITH OTHER AMERICAN FOSSIL FAUNAS.

It has been shown that the Bear River fauna, so far as it is known, consists wholly of invertebrates, and that with the exception of some Ostracod crustaceans they are all mollusks. For the present purpose there is no necessity for comparing this invertebrate fauna with much the larger part of the fossil faunas of North America further than to

¹Observations hitherto made of the Bear River formation do not forbid such an assumption, but both fresh-water and brackish-water forms have been found so distributed throughout the broad Laramie formation as seemingly to forbid the assumption that the former lived only along the borders of the Laramie sea.

demonstrate the fact of its nonmarine origin. Besides this, nonmarine fossils are of such rare occurrence in Paleozoic formations that comparisons of the Bear River fauna must necessarily be confined to the known Mesozoic and Cenozoic faunas. It will be sufficient for the present purpose to compare it with that of the Laramie formation, those of the Wasatch, Green River, and Bridger formations collectively, that of the Dakota formation, and that of the upper part of the Jurassic as it is known in Colorado and Wyoming, beginning with the fauna of the last-named strata.

*The fresh-water Jurassic invertebrates of Colorado and Wyoming.*¹

MOLLUSCA.

CONCHIFERA.

Family UNIONIDÆ.

Genus UNIO Retzius.

Unio felchii White.

U. toxonotus W.

U. macropisthus W.

U. iridoides W.

U. lapilloides W.

U. stewardi W.

GASTEROPODA.

Family LIMNÆIDÆ.

Genus LIMNÆA Lamarck.

Limnæa ativuncula W.

L. consortis W.

L. ? accelerata W.

Genus PLANORBIS Müller.

Planorbis veternus Meek and Hayden?

Genus VORTICIFEX Meek.

Vorticifex stearnsii W.

Family VALVATIDÆ.

Genus VALVATA Müller.

Valvata scabrida M. and H.?

CRUSTACEA.

OSTRACODA.

Metacypris forbesii Jones.

Metacypris ———?

Darwinula leguminella Forbes.

Cypris purbeckensis? F.

Cypris ———?

Cypris ———?

¹ This list is compiled from Bulletin No. 29 of the U. S. Geological Survey. The following species, which are included with Jurassic forms in that bulletin, are omitted from this list because they came from a more northern region, and it is not yet certain that they really came from the Jurassic: *Unio nuchalis* Meek and Hayden, *Viviparus gilli* M. and H., *Lioplacodes veternus* M. and H., and *Neritina nebrascensis* M. and H. These omissions, however, will not affect the comparisons of this fauna with that of the Bear River formation which are made in this bulletin.

Upon examination of the foregoing list of Jurassic mollusca two significant facts are apparent: First, they are all of such forms as are without hesitation referred to a fresh-water habitat; second, although they are specifically distinct from any others, they are all closely related to species which occur in several other fresh-water formations of later age as well as to fresh-water species which are now living. These facts, together with the absence from the Jurassic fauna of brackish-water molluscan forms, which is shown by the foregoing list, and the further fact that it is mainly such forms as were capable of living in brackish water that characterize the Bear River fauna, render a comparison of the two faunas of comparatively little value for present purposes.

The foregoing remarks apply to the mollusca, but there is an interesting relationship between the Ostracoda of the Bear River formation and those of the Jurassic strata of Colorado and Wyoming. The character of this relationship may be seen by comparing the closing entries of the preceding list with the list of the Bear River Ostracoda on page 62, and also by comparing the figures of the latter on Pl. XI of this bulletin with those of the former on Pl. IV of Bulletin No. 29 of the United States Geological Survey.

This relationship of the Bear River Ostracoda to those of the fresh-water Jurassic of Colorado is very interesting, because certain of the forms in each case are respectively similar, and because no similar forms are yet known in any other of the North American formations. It is hardly probable, however, that much important geological information will be derived from these facts, especially in view of the extreme rarity of the Ostracoda in all the known North American faunas of the later formations. Indeed, they are so rare in those formations that it has not been thought necessary to enumerate them in the following lists.

The known invertebrate fauna of the Dakota formation is so meager that only a limited comparison between it and that of the Bear River fauna can be made; but the fact that the Dakota formation is the only one besides the Bear River which contains a species referable to *Pyrgulifera* makes such a comparison desirable. I have elsewhere shown that of the invertebrate fossils which have been published as having been obtained from the Dakota formation, a part are plainly remains of denizens of marine waters, and that the others are remains of denizens of either brackish or fresh waters.¹

No member of the Bear River fauna being regarded as indicating a marine habitat, the names of only the fresh-water and brackish-water species of the Dakota invertebrates are given in the following list:

¹See "Notes on the invertebrate fauna of the Dakota formation, with descriptions of new molluscan forms." Ann. Rept. U. S. National Museum for 1892, pp. 131-138 and one plate.

Invertebrate fauna of the Dakota formation.

MOLLUSCA.

CONCHIFERA.

Family UNIONIDÆ.

Genus MARGARITANA Schumacher.

Margaritana nebrascensis Meek.

Genus UNIO Retzius.

Unio barbouri White.

U. ——— ? W.

Family CORBICULIDÆ.

Genus CORBICULA Mühlfeldt.

Cyrena [Corbicula?] dakotaensis Meek and Hayden.

Family CORBULIDÆ.

Genus CORBULA Bruguiere.

Corbula hicksii W.

GASTEROPODA.

Family CERIPHASIIDÆ.

Genus GONIOBASIS Lea.

Goniobasis jeffersonensis W.

G. ——— ? W.

Family MELANIIDÆ.

Genus PYRGULIFERA Meek.

Pyrgulifera meekii W.

Family VIVIPARIDÆ.

Genus VIVIPARUS Montfort.

Viviparus hicksii W.

Although, with the exception of Margaritana, all the genera of the foregoing list of Dakota species are represented in the Bear River fauna, the Dakota fauna as a whole is not such as to suggest the equivalency of the two formations. There are, however, two significant facts to be observed in this connection. First, there is stratigraphical evidence that there is no great difference in the geological age of the Bear River and Dakota formations; second, in America only these two formations are known to contain remains of Pyrgulifera.

The next nonmarine fauna in ascending chronological order with which the Bear River fauna may be compared is that of the Upper Cretaceous Dunvegan series of Canada, the fauna of which has been briefly discussed on pages 28 and 29. It was there shown that the character of the fauna, although it includes some molluscan forms which are closely related to certain members of the Bear River fauna, is not such as to indicate an identity of the formations which respectively contain those faunas. Besides this, the Dunvegan fauna is not yet known to contain any of the molluscan genera which are especially characteristic of the Bear River fauna.

It is not thought necessary to compare the Bear River fauna with that of the Belly River series of Canada, because of the close faunal relationship of that series with the Laramie formation.

The fauna with which, above those of all other North American formations, it is desirable to compare the Bear River fauna is that of the great Laramie formation, this being the one with which the Bear River formation has long been confounded. The following is a list of the invertebrate species which are now assigned to the Laramie fauna proper. It is given here for comparison with that of the Bear River fauna, which is given on pages 64 and 65.

*Invertebrate fauna of the Laramie formation.*¹

MOLLUSCA.

CONCHIFERA.

Family OSTREIDÆ.

Genus OSTREA Linnæus.

Ostrea glabra Meek and Hayden.

O. subtrigonalis Evans and Shumard.

Family ANOMIIDÆ.

Genus ANOMIA Linnæus.

Anomia micronema Meek.

A. gryphorhynchus M.

Family MYTILIDÆ.

Genus MODIOLA Lamarck.

Modiola (Brachydontes) *regularis* White.

M. (B.) laticostata W.

Family UNIONIDÆ.

Genus ANODONTA Cuvier.

Anodonta parallela W.

A. propatoris W.

Genus UNIO Retzius.

Unio aldrichi W.

U. brachyopisthus W.

U. conesii W.

U. cryptorhynchus W.

U. danæ M. and H.

U. deweyanus M. and H.

U. endlichi W.

U. goniambononatus W.

U. gonionotus W.

U. holmesianus W.

U. primævus W.

U. priscus M. and H.

¹In compiling this list I have, of course, omitted the species which belong to the Bear River fauna, all of which were formerly referred to the Laramie. The following species were also formerly referred to the Laramie, but I have omitted them from this list because I now understand them to belong to the overlying Wasatch formation, in the list of which they will appear on a following page: *Unio mendax* White, *Pisidium saginatum* W., *Macrocyclus spatiosa* Meek and Hayden, *Helix* (*Spatula*?) *sepulta* W., *H. (Triodopsis?) evanstonensis* W., *Hydrobia recta* W., and *H. utahensis* W.

U. proavitus White.
U. propheticus W.
U. senectus W.
U. subspatulatus Meek.

Family CYRENIDÆ.

Genus SPHÆRIUM Scopoli.

Sphærium formosum Meek and Hayden.
S. planum M. and H.
S. recticardinale M. and H.
S. subellipticum M. and H.

Genus CORBICULA Mergerle.

Corbicula augheyi W.
C. berthoudi W.
C. cardiniæformis W.
C. cleburni W.
C. cytheriformis M. and H.
C. fracta M.
C. macropistha W.
C. nebrascensis M. and H.
C. obesa W.
C. occidentalis M. and H.
C. planumbonata M.
C. subelliptica M. and H.
C. umbonella M.

Family CORBULIDÆ.

Genus CORBULA Bruguiere.

Corbula subtrigonalis M. and H.
C. undifera M.

GASTEROPODA.

Family LIMNÆIDÆ.¹

Genus LIMNÆA Lamarck.

Limnæa (*Pleurolimnæa*) *tenuicarinata* M.

Genus PLANORBIS Müller.

Planorbis amplexus M. and H.
P. convolutus M. and H.
P. kanabensis W.
P. planoconvexus M. and H.

Family PHYSIDÆ.

Genus PHYSA Draparnaud.

Physa copei W.
P. felix W.
P. kanabensis W.

Genus BULINUS Adanson.

Bulinus atavus W.
B. longiusculus M. and H.
B. rhomboidens M. and H.
B. subelongatus M. and H.

¹No representative of the Auriculidæ, which family is so well represented in the Bear River fauna, has been found in the Laramie formation. Therefore this list begins with the Limnæidæ.

Family ANCYLIDÆ.

Genus ACROLOXUS Beck.

Acroloxus minutus Meek and Hayden.

Family VITRINIDÆ.

Genus VITRINA Draparnaud.

Vitrina? *obliqua* M. and H.

Genus HYALINA Agassiz.

Hyalina? *occidentalis* M. and H.

Family HELICIDÆ.

Genus HELIX Linnæus.

Helix (*Strobilia?*) *kanabensis* White.*H. vetustus* M. and H.

Genus THAUMASTUS Albers.

Thaumastus *linnæiformis* M. and H.

Genus COLUMNA Perry.

Columna teres M. and H.*C. vermicula* M. and H.

Family NERITIDÆ.

Neritina (*Velatella*) *baptista* W.*N. bruneri* W.*N. volvilineata* W.

Family CERITHIIDÆ.

Genus CERITHIDEA Swainson.

Cerithidea nebrascensis M. and H.

Family MELANIIDÆ.

Genus MELANIA Lamarck.

Melania insculpta Meek.*M. wyomingensis* M.

Genus MELANOPSIS Ferussac.

Melanopsis americana W.

Family CERIPHASIIDÆ.

Genus GONIOBASIS Lea.

Goniobasis convexa M. and H.*G. gracilenta* M. and H.*G. invenusta* M. and H.*G. omitta* M. and H.*G. nebrascensis* M. and H.*G. sublævis* M. and H.*G. tenuicarinata* M. and H.

Genus CASSIOPELLA White.

Cassiopella turricula W.

Family RISSOIDÆ.

Genus HYDROBIA Hartmann.

Hydrobia anthonyi M. and H.*H. eulimoides* M.*H. subconica* M.*H. warrenana* M. and H.

Genus MICROPYRGUS M.

Micropyrgus minutulus Meek and Hayden.

Family VIVIPARIDÆ.

Genus VIVIPARUS Montfort

Viviparus conradi M. and H.*V. leai* M. and H.*V. leidy* M. and H.*V. peculiaris* M. and H.*V. plicapressus* White.*V. prudentius* W.*V. raynoldsianus* M. and H.*V. vetustus* M. and H.*V. trochiformis* M. and H.*V. ionicus* W.*V. panguitchensis* W.

Genus TULOTOMA Haldeman.

Tulotoma thompsoni W.

Genus CAMPELOMA Rafinesque.

Campeloma multilineata M. and H.*C. multistriata* M. and H.*C. producta* W.*C. vetula* M. and H.

Family VALVATIDÆ.

Genus VALVATA Müller.

Valvata montanaensis Meek.*V. parvula* M. and H.*V. subumbilicata* M. and H.

ANNULOSA.

INSECTA.

Corydalites fecundum Scudder.¹

It will be seen that with the exception of some insect egg masses the Laramie invertebrate fauna as represented by the foregoing list consists entirely of molluscan remains. Doubtless some such fresh-water and brackish-water crustaceans as are known to have existed in late Cretaceous and early Tertiary time lived in the Laramie sea, and the discovery of remains of the Ostracoda especially might have been expected, but no such remains have yet been discovered. In comparing the Laramie fauna with the Bear River fauna, so far as both are now known, we are therefore confined to the mollusca.

Beginning this comparison with the Conchifera, we find a good degree of similarity so far as genera and families are concerned, and no striking contrast between them is observed except as regards the number of species which represent certain of the genera, *Unio* and *Corbicula*, for example, and the absence of *Anomia* from all the Bear River collec-

¹ These remains consist only of egg masses.

tions, while that genus prevails in the Laramie. The only types among the Bear River Conchifera which need be contrasted with any of those of the Laramie are those which are represented by *Unio belliplicatus* and *Corbula pyriformis*, respectively. This contrast, however, is one only, or mainly, of unusual size and obesity in the case of the *Corbula*, and of external ornamentation in the case of the *Unio*.

The contrast between the Bear River and Laramie faunas is much greater as regards the Gasteropoda. Upon beginning a comparison of the members of this class of the Mollusca, as represented by the Bear River and Laramie faunas, we are met by the entire absence of the Auriculidæ from the Laramie fauna, although that family is represented in the Bear River fauna by five species and four genera. This contrast is still more conspicuous because two of those genera are yet known only in the Bear River fauna.

The pulmoniferous mollusca are much more fully and variously represented in the Laramie fauna than they are in the Bear River fauna. This is especially the case with those of land habitat, the paucity of whose remains in the Bear River fauna has already been pointed out. The suggestion has also been made that this paucity was due to a want of favorable conditions for the preservation of their remains in the Bear River sediments. Whatever may have been the facts in this case, the few pulmoniferous mollusca whose remains have been discovered in the Bear River strata were of such a character as to be not inconsistent with such a fauna as that of the Laramie. Therefore the observable contrast between the Bear River and Laramie faunas, as regards the pulmoniferous mollusca exclusive of the Auriculidæ, is one of fullness and paucity of representation rather than of diversity of types.

The two Bear River species of the Neritidæ, and two of the three Laramie species belonging to that family, differ too little in generic characteristics from other Cretaceous, Tertiary, and living forms to attract particular attention, but one of the Laramie species, *Neritina* (*Velatella*) *baptista*, belongs to an extinct subgenus. This subgenus is not yet known to occur in the Bear River fauna, but it is found in that of the immediately overlying Colorado formation, and it probably existed somewhere during the Bear River epoch.

As regards faunal types, the most conspicuous contrast between the Laramie and Bear River faunas is observable in the family Melaniidæ. In the Laramie fauna the genera *Melania*, *Goniobasis*, *Cassiopella*, and *Melanopsis* are represented, but no representative of any of those genera is known in the Bear River fauna.¹ In the latter fauna, as it is now known, the family Melaniidæ is represented by only two genera, *Pyrgulifera* and *Pachymelania*, neither of which genera is known to occur in any other North American fauna. The conspicuous contrast

¹It is true that some authors have referred certain forms to *Melanopsis* which are congeneric with *Pyrgulifera humerosa*, and that I have formerly referred those Bear River species to *Goniobasis* which I now assign to *Pachymelania*, but the true generic characteristics of those forms are shown on preceding pages of this bulletin.

between the Laramie and Bear River faunas which is thus presented by the Melaniidæ is made still more conspicuous by the abundance of individual shells of the different species of those genera in the Bear River strata, and by the fact that those species are among the most characteristic members of the Bear River fauna.

The remaining members of the Laramie fauna to be compared with the Bear River fauna are all branchiferous gasteropods. They belong to genera which occur also in the Bear River fauna or to closely allied genera. Therefore this part of the Laramie fauna does not present a strong contrast to the Bear River fauna, except as regards the greater number of Laramie species, especially of the Viviparidæ. These correspondencies between the Laramie and Bear River faunas are not, however, of such a character as necessarily to suggest the geological equivalency of the formations containing them; and besides this, the contrasts which have been mentioned are inconsistent with such equivalency.

The Wasatch, Green River, and Bridger formations come next in geological age to the Laramie among North American nonmarine formations, and they are by all geologists referred to the Eocene. All three of these formations are so intimately connected with one another, both by faunal similarity and the ranging of certain species from one to another, that for the present purpose the molluscan faunas of all of them will be represented together in the following list. It will also be seen by the footnotes accompanying the list that certain of the fresh-water Laramie species range up into the lowest of these three formations.

The Molluscan fauna of the Wasatch, Green River, and Bridger formations.

CONCHIFERA.

Family UNIONIDÆ.

Genus UNIO Retzius.

Unio clinopisthus White.
U. haydeni Meek.
U. mendax W.
U. rectoides W.
U. shoshonensis W.
U. tellinoides Hall.
U. washakiensis M.

Family CYRENIDÆ.

Genus SPHÆRIUM Scopoli.

Sphærium formosum Meek and Hayden.¹

Genus PISIDIUM Pfeiffer.

Pisidium saginatum W.

¹Survival from the Laramie epoch.

GASTEROPODA.

Family LIMNÆIDÆ.

Genus LIMNÆA Lamarck.

Limnæa minuscula White.

L. similis Meek.

L. vetusta M.

Genus PLANORBIS Müller.

Planorbis æqualis W.

P. cirratus W.

P. convolutus Meek and Hayden.¹

P. militaris W.

P. spectabilis M.

P. utahensis M.

Family PHYSIDÆ.

Genus PHYSA Draparnaud.

Physa bridgerensis M.

P. bullatula W.

P. kanabensis W.¹

P. pleuromatis W.

Genus BULINUS Adanson.

Bulinus atavus W.¹

Family ANCYLIDÆ.

Genus ACROLOXUS Beck.

Acroloxus actinophorus W.

Family VITRINIDÆ.

Genus MACROCYCLIS Beck.

Macrocyclus spatiosa M. and H.

Family HELICIDÆ.

Genus HELIX Linnaeus.

Helix (*Triodopsis*?) *evanstonensis* W.

H. (*Arianta*?) *riparia* W.

H. (*Aglaia*?) *peripheria* W.

H. (*Patula*?) *sepulta* W.

H. veterna M. and H.

Family PUPIDÆ.

Genus PUPA Lamarck.

Pupa leidy M.

P. arenula W.

P. atavuncula W.

P. incolata W.

Family SUCCINIDÆ.

Genus SUCCINEA Draparnaud.

Succinea papillispira W.

Family CERIPHASIIDÆ.

Genus GONIOBASIS Lea.

Goniobasis filifera W.

G. nebrascensis M. and H.¹

G. tenera Hall.

G. tenuicarinata M. and H.¹

¹ Survival from the Laramie epoch.

Family RISSOIDÆ.

Genus HYDROBIA Hartmann.

Hydrobia recta White.*H. utahensis* W.

Genus BYTHINELLA Moquin-Tandon.

Bythinella gregaria Meek.

Genus MICROPYRGUS Meek.

Micropyrgus minutulus Meek and Hayden.¹

Family VIVIPARIDÆ.

Genus VIVIPARUS Montfort.

Viviparus nanus W.*V. paludinæformis* Hall.*V. trochiformis* M. and H.¹*V. wyomingensis* M.

The foregoing list of Eocene nonmarine mollusca plainly shows that any comparison of the fauna which it represents with the Bear River fauna must be mainly one of contrast; and the contrast is all the greater because of the absence from this later fauna of any other than purely fresh-water forms. It is also apparent that this fauna is not only closely related to the fresh water and land portion of the Laramie fauna by a considerable number of specifically identical forms, but it is also closely related to the living fresh-water and land molluscan fauna of North America by the generic identity of a very large majority of its members. On the contrary, the Bear River fauna contains only half a dozen forms that can be regarded as closely related to any of the species enumerated in the foregoing list, these being in part palustral pulmoniferous and in part fresh-water branchiferous mollusca. Geologically such a comparison has the effect of showing that the Bear River fauna, which was originally assigned to the Tertiary, is conspicuously different from any North American Tertiary fauna.

In making a general comparison of the Bear River fauna with the other nonmarine fossil faunas of North America, as represented by the three foregoing lists and the remarks which accompany them, it is desirable to recall attention to those features of the Bear River fauna by which it differs conspicuously from all the others. Reference is here especially made to the Auriculidæ and Melaniidæ, because it is the members of these two families that give the Bear River fauna its most distinctive character. This faunal character is all the more conspicuous because, of the six genera which represent those two families, only two of them are known in any other North American fauna, either fossil or recent. To the geological investigator this faunal character of the Bear River formation is physically conspicuous, because of the comparative abundance of the shells of some of the species belonging to the two families just mentioned.

¹ Survival from the Laramie epoch.

In view of the similarities and contrasts between such faunas as have been discussed in the preceding paragraphs, one is naturally led to an inquiry as to their causes. It is not to be expected that all such inquiries can be satisfactorily answered, but the following facts and suggestions are deemed worthy of consideration.

Marine waters have been of world-wide extent ever since life began to exist in them, and interruptions of their physical continuity during the whole course of geological time have never been more than partial or local. It is therefore easy to comprehend how unbroken genetic lines of descent may have occurred in marine waters throughout the whole range of geological time. It is, however, much more difficult to understand how such lines of descent could have been preserved in the case of nonmarine faunas, especially those of their fresh-water branchiferous members, because a change to dry land or to a saline condition of habitat would have been fatal to them. This difficulty is increased when we take into consideration the fact that fresh-water molluscan faunas similar to those now living have abounded ever since the earlier epochs of Mesozoic time, and that many of them contain forms so closely like members of living faunas that it is often impracticable to clearly diagnose them as specifically different. Equally embarrassing is the further fact that the greater part of the ancient ichthyic types which have survived to the present day are found among fresh-water fishes.

In view of numerous facts brought out by paleontological investigation, there seems to be no room for reasonable doubt that in the course of geological time many forms have been developed independently, or along separate genetic lines, the fossil remains of which present no features by which they can be satisfactorily assigned to separate genera; and it is even conceivable that some of the admitted fossil species have had a similarly independent origin. As a rule, however, I think it necessary to assume that closely similar fossil faunas, or important divisions of the same, have a more or less close genetic relationship, notwithstanding the frequent difficulty of understanding how such a relationship could have been maintained.

In a former publication¹ I have suggested that genetic lines of descent of fresh-water branchiferous animals could have been, and in most cases probably were, preserved by means of the persistence of rivers from epoch to epoch of geological time, thus securing a continuance of congenial aquatic habitat through a series of geological epochs; that is, in the process of time lakes inhabited by branchiferous fresh-water faunas naturally became drained by the corrasive deepening of the channels of their outlets, but those faunas found a congenial habitat in the resulting fluviatile waters, which debouched either into other lacustrine waters or more or less directly into the sea.

This theory of the manner of genetic descent of fresh-water faunas seems to apply well to the fresh-water and land portion of the Laramie

¹ Third Ann. Rept. U. S. Geol. Surv., pp. 75-80, 1883.

molluscan fauna, and also to the whole fauna of the Wasatch, Green River, and Bridger formations as represented by the foregoing list. The collective fauna of the three last-named formations shows an intimate relationship to the Laramie fauna, not only by a general similarity of types but by identity of certain of the species. It is therefore natural to infer that the fauna of these Eocene formations was, at least in part, derived by direct genetic descent from the earlier Laramie fauna.

Furthermore, because so large a part of the generic and subgeneric, as well as more general, types of fresh-water and land mollusca of those Eocene formations, and also of the Laramie, are identical with forms which are now living in the great area drained by the Mississippi River system, it is equally natural to infer that the latter were derived by direct descent from their Eocene and Laramie congeners; that is, it is assumed that the fluvial perpetuation of the outlet or outlets of the Laramie sea conveyed its fresh-water fauna in part to the Eocene lakes and in part retained it in fluvial waters, some of which are flowing to-day as a part of the Mississippi drainage system. This view also finds support in abundant geological evidence that after the Laramie epoch no marine waters prevailed over that great interior portion of the continent in which the formations referred to occur.

It is much more difficult to understand how the Laramie sea may have obtained its fresh-water fauna than how its distinctive types may have been genetically perpetuated; and it is equally difficult to understand how genetic lines of descent could have been so perpetuated from those Jurassic and Bear River faunas, which are represented by the foregoing lists, as to connect with the faunas of subsequent epochs, or with those of the present time. Although we necessarily assume that a part of such lines have been maintained continuously, each through the whole or a part of those geological epochs, it is evident that others of them would have become diverged from the main lines of succession and destroyed by some of those physical changes which marked the successive epochs.

In view of the facts which have been set forth on the preceding pages, I think we may reasonably assume that one of those divergent lines terminated in the Bear River fauna; that is, at the close of the Bear River epoch the area which its nonmarine waters had occupied having become overspread by the marine waters in which the Colorado formation was deposited, it is not probable that any fluvial outlet of the former nonmarine waters was perpetuated, and there was therefore no provisional habitat in which the Bear River fauna might have been preserved. It was probably in this way that the distinguishing types of that fauna became extinct, together with others of its members which were not so specially characteristic of it.

It was suggested on preceding pages that certain members of the Bear River fauna which were more able than others to live in strongly saline waters survived in the succeeding marine waters of the Colo-

rado formation. This may really have been the case, but such a fact would not necessarily affect the suggestion that the typical Bear River forms, which were doubtless unable to thrive in waters of full marine saltness, were extinguished in the manner indicated.

While the foregoing suggestions as to the fate of those typical forms are evidently rational, and probably indicate the true course of events in that case, no observations hitherto made warrant any definite suggestion as to their ancestry. This lack of suggestive information emphasizes the fact that the fauna which they characterize is unique among the North American fossil faunas.

THE GEOGRAPHICAL AND TIME RANGE OF PYRGULIFERA.

It has been shown on preceding pages that the Bear River fauna, as a whole, is unique among North American fossil faunas, and also that those of its members which especially and conspicuously characterize it are so different from any of the members of other North American faunas that one is hardly justified in offering any suggestions as to their ancestry or progeny; and little can be suggested concerning their more remote faunal relationship.

The most conspicuous generic type among these characteristic members of the Bear River fauna is *Pyrgulifera*, and peculiar interest attaches to this genus because of the remarkable cases of both geographical and chronological isolation which it presents in the different parts of the world where it is known. In North America this genus has not only the extremely limited time range which has been explained, but, with the exception of a single specimen, evidently referable to this genus, which was lately discovered in Dakota strata in Nebraska, its known geographical distribution is confined to a comparatively narrow belt of country which does not exceed 150 miles in length. This genus is also known to occur in several of the nonmarine fossil faunas of Europe, and to be represented by living species in Africa, but beyond this it is not known to have a representative in any other fauna, nor in any other parts of the world.

The species constituting the European faunas in which *Pyrgulifera* occurs have been published by various authors and at various times and places, but a good summary of them, so far as the needs of the present discussion are concerned, may be obtained from the publications of M. Philippe Matheron,¹ Prof. Dr. Paul Oppenheim,² and Dr. Leopold von Tausch,³ especially the latter.

¹Catalogue méthodique et descriptif des corps organisés fossiles du département des Bouches-du-Rhône et lieux circonvoisins, Marseille, 1842.

²Ueber einige Brackwasser- und Binnen-Mollusken aus der Kreide und dem Eocän Ungarns. Zeitschr. Deutsch. geol. Gesell., Band XLIV, Heft 4, Berlin, 1892.

³1. Ueber die Fauna der nicht-marinen Ablagerungen der oberen Kreide des Csingerthales bei Ajka im Bakony (Veszprimer Comitát, Ungarn); und über einige Conchylien der Gosaumergel von Aigen bei Salzburg. Abhandl. K.-k. geol. Reichsanstalt, Band XII, No. 1, pp. 1-30, pls. i-iii, Wien, 1886.

2. Ueber einige Conchylien aus dem Tanganyika-See und deren fossile Verwandte. Sitzungsber. K. Akad. Wiss., Abtheil. I, Juli Heft, Wien, 1884.

3. Ueber die Fossilien von St. Briz in Südsteiermark. Verhandl. K.-k. geol. Reichsanstalt, No. 9, Wien, 1888.

The European nonmarine faunas referred to occur respectively in the following formations: The Lignitic formation of southern France, the coal-bearing Upper Cretaceous strata near Ajka in western Hungary, the nonmarine portion of the Gosau formation of the northeastern Alps, the St. Briz deposit in southern Styria, and in probable equivalents of certain of those formations in other parts of Europe. Ten species of *Pyrgulifera* are recognized by Dr. von Tausch and Professor Oppenheim among those faunas. The following list shows the names by which they designate them:

<i>Pyrgulifera acinosa</i> Zekeli.	<i>P. humerosa</i> Meek.
<i>P. ajkaensis</i> Tausch.	<i>P. lyra</i> Matheron.
<i>P. armata</i> Matheron.	<i>P. pichleri</i> Hoernes.
<i>P. glabra</i> Hantken.	<i>P. rickeri</i> Tausch.
<i>P. gradata</i> Rolle.	<i>P. striata</i> Tausch.

Although the faunas just mentioned, each as a whole, are quite different from one another, Dr. von Tausch has shown that certain of the species of *Pyrgulifera* range from one formation to another. For example, he has shown that *Pyrgulifera pichleri* and *P. acinosa* are found associated together in both the Gosau and Ajka formations, and also that both *P. armata* and *P. lyra* occur together in the Ajka formations as well as in the Lignitic formation of southern France, where they were originally discovered by Matheron.

The discovery of a form in the Ajka formation which can not be distinguished from typical examples of *Pyrgulifera humerosa*, the most characteristic species of the Bear River formation, is very remarkable. It is sufficiently difficult to understand how *Pyrgulifera*, or any other nonmarine genus of branchiferous mollusca, could have become so dispersed from one genetic center as to occupy isolated areas on separate continents, but it is still more difficult to believe that the North American *P. humerosa* represents the European form ancestrally, or vice versa. I am therefore inclined to believe that, notwithstanding the apparent identity of the Ajka and Bear River forms, they originated independently.

Still, such a distribution and commingling of species as Dr. von Tausch has shown to occur in Europe is usually accepted by geologists as indicating a more or less direct genetic relationship between the faunas which respectively contain them, and consequently as indicating at least an approximate contemporaneity of origin for the formations which those faunas characterize. It is consistent with these views to regard the Ajka, Gosau, and French Lignitic formations as having been at least approximately contemporaneous in their origin. There being no reason to doubt the Upper Cretaceous age of the Ajka and Gosau formations, this view of the question requires the reference of the Lignitic formation of southern France to the same age, notwithstanding its original reference to the Tertiary. In short, with only one exception, there seems to be no reason to doubt the Upper Cre-

taceous age of any of the European strata which contain the remains of any of the known species of *Pyrgulifera*.

The exception referred to is that of the St. Briz deposit in southern Styria, in which is found the *Pyrgulifera gradata* of Rolle. Although some geologists have entertained doubts as to the true age of the St. Briz deposit, several important facts favor its reference to the base of the Tertiary, to which horizon both Dr. Tausch and Professor Oppenheim refer them. Admitting the Tertiary age of this deposit, the time range of *Pyrgulifera* in Europe, although somewhat longer than it is known to have been in America, seems to have been confined to the upper part of the Upper Cretaceous and the base of the Tertiary.

Briefly summarizing the foregoing statements concerning the geographical and time range of the genus *Pyrgulifera*, we observe that it is at present known to occur only in North America, Europe, and Africa, and that its earliest appearance is not known to have been earlier than the Upper Cretaceous period.

In North America it is known only in one formation, which belongs at or near the base of the Upper Cretaceous. This formation is found only in the interior portion of the continent, where it occupies a comparatively small area.

In Europe it is found only in the southern portion of the continent, and its time range is apparently from near the middle of the Upper Cretaceous to the base of the Tertiary, inclusive.

In Africa it is known only by living forms, which have yet been found only in Lake Tanganyika.¹

¹The following publications contain discussions of the molluscan fauna of Lake Tanganyika:

Proc. Zool. Soc. London for 1879, p. 348; for 1880, p. 344; for 1881, pp. 276, 558.

Annals Mag. Nat. Hist., 5th ser., Vol. VI, p. 425, London, 1880.

Jour. de conch., Paris, for 1881, pp. 105, 277.

Nature, Vol. XXV, pp. 101-102, 218, 1881.

Proc. U. S. Nat. Mus., Vol. V (for 1882), pp. 94-99, 1883.

Am. Jour. Sci., 3d ser., Vol. XXIX, pp. 277-280, 1885.

Sitzungsb. K. Akad. Wiss. Abtheil I, Juli Heft, Wien, 1884.

PLATE II.

PLATE II.

OSTREA HAYDENI (p. 32).

Fig. 1. Lower valve; exterior view.

Fig. 2. Upper valve; interior view.

MODIOLA PEALEI (p. 33).

Fig. 3. Imperfect right valve.

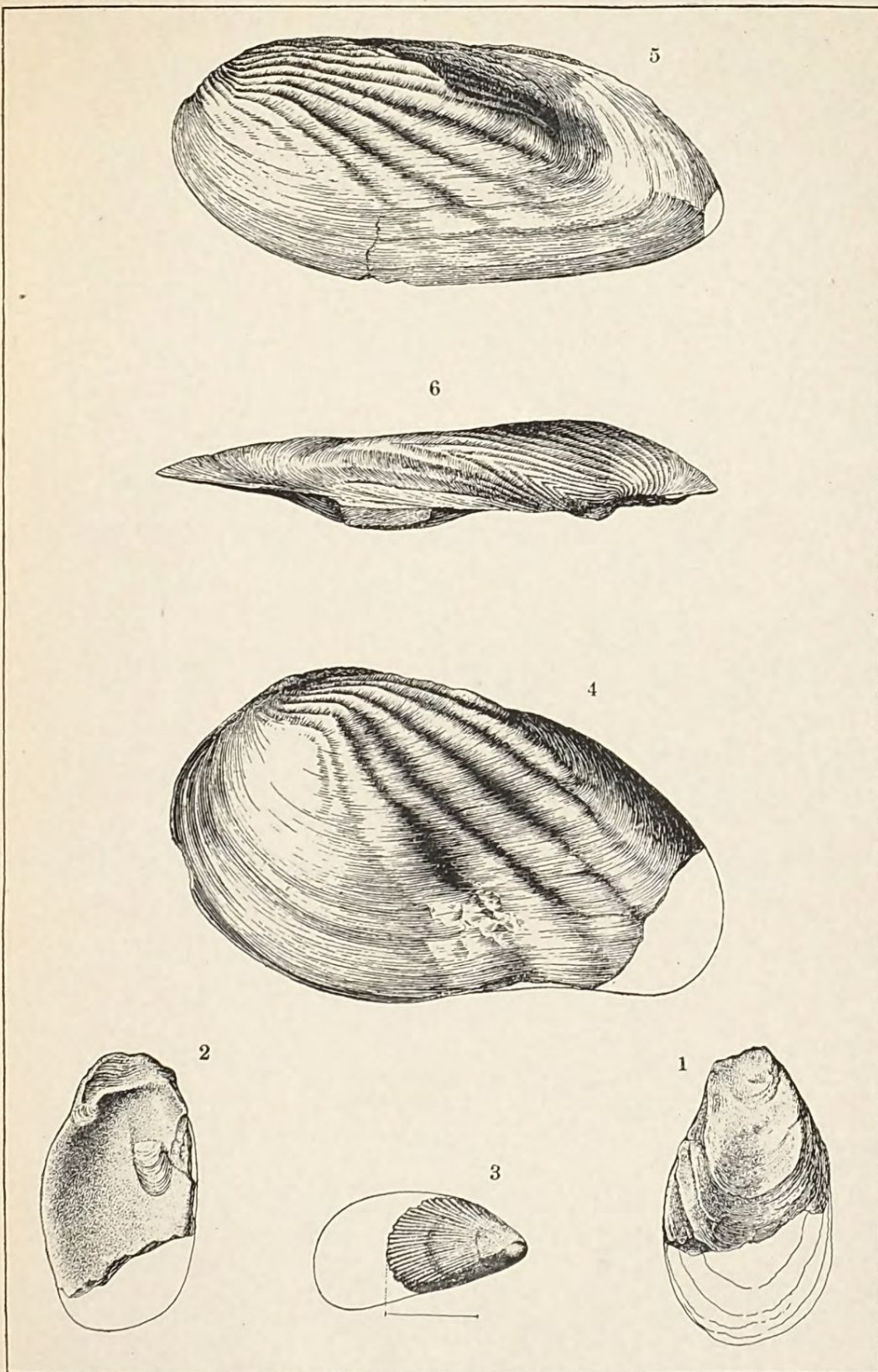
UNIO BELLIPLICATUS (p. 34).

Fig. 4. Left valve of usual form.

Fig. 5. Another left valve, more elongate.

Fig. 6. Dorsal view of a left valve.

All natural size.



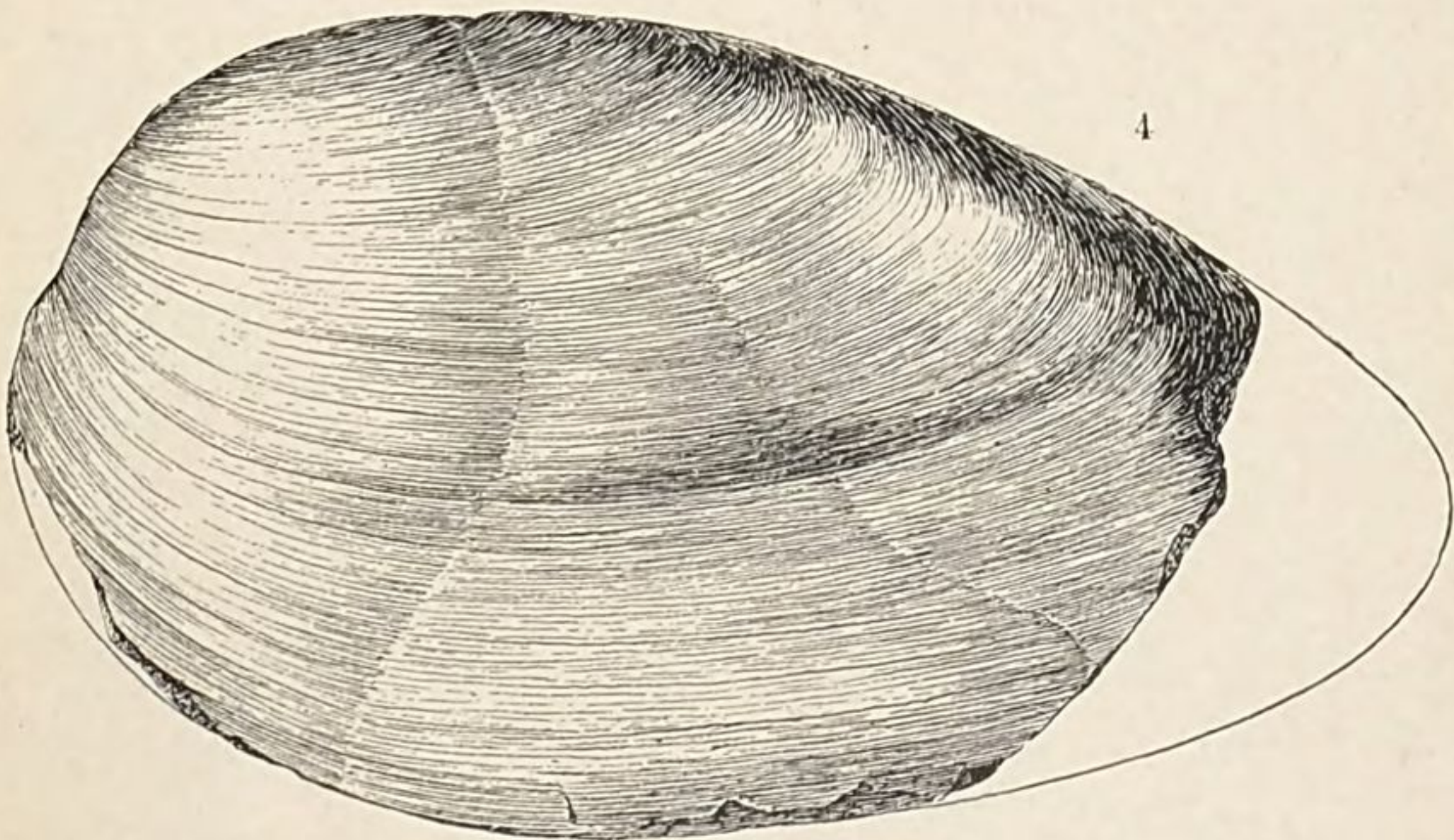
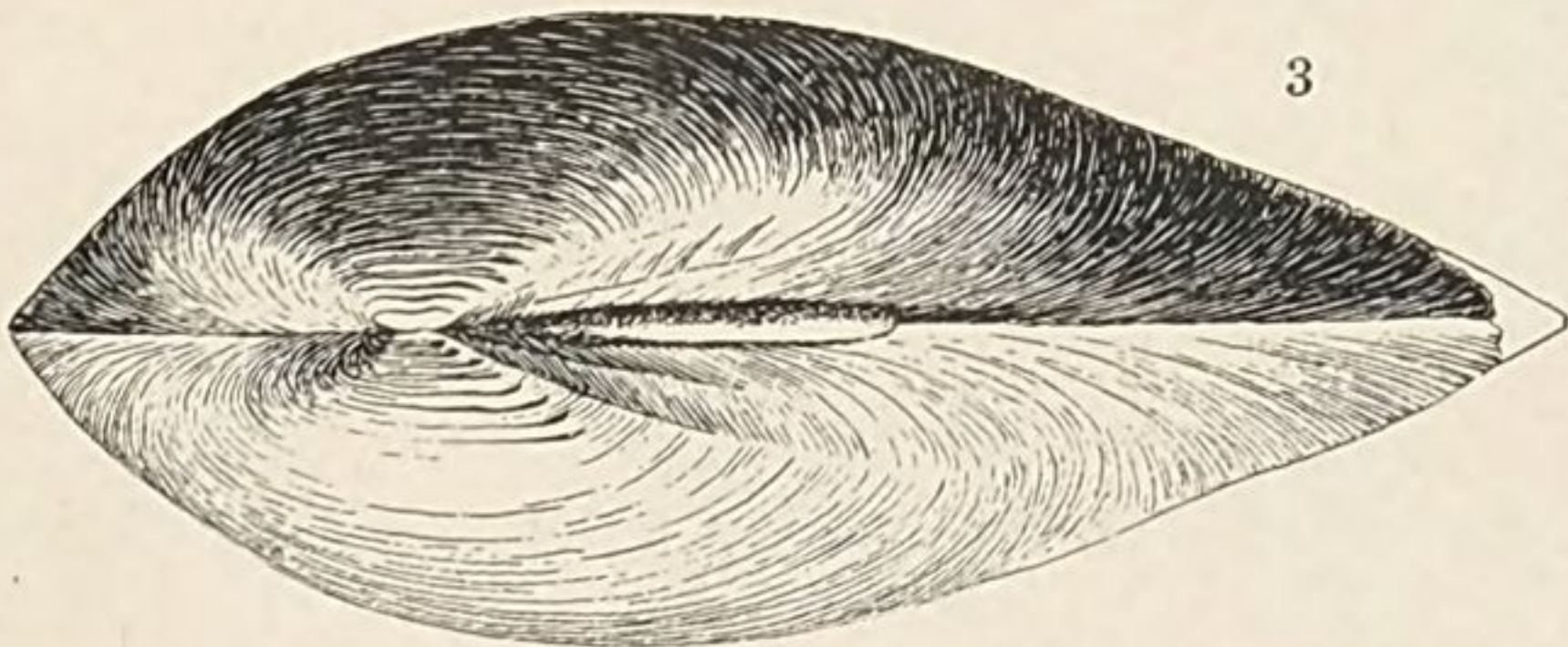
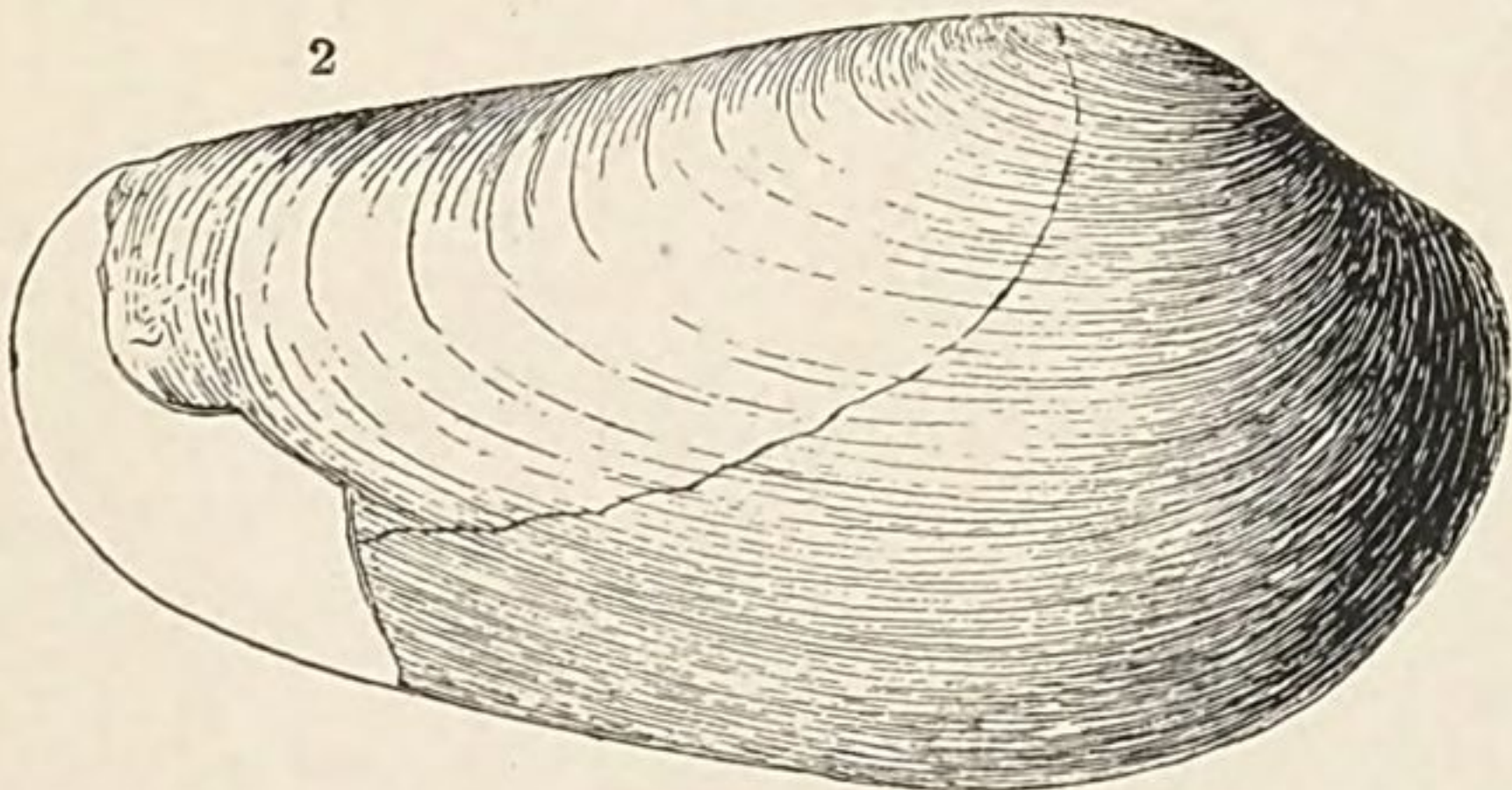
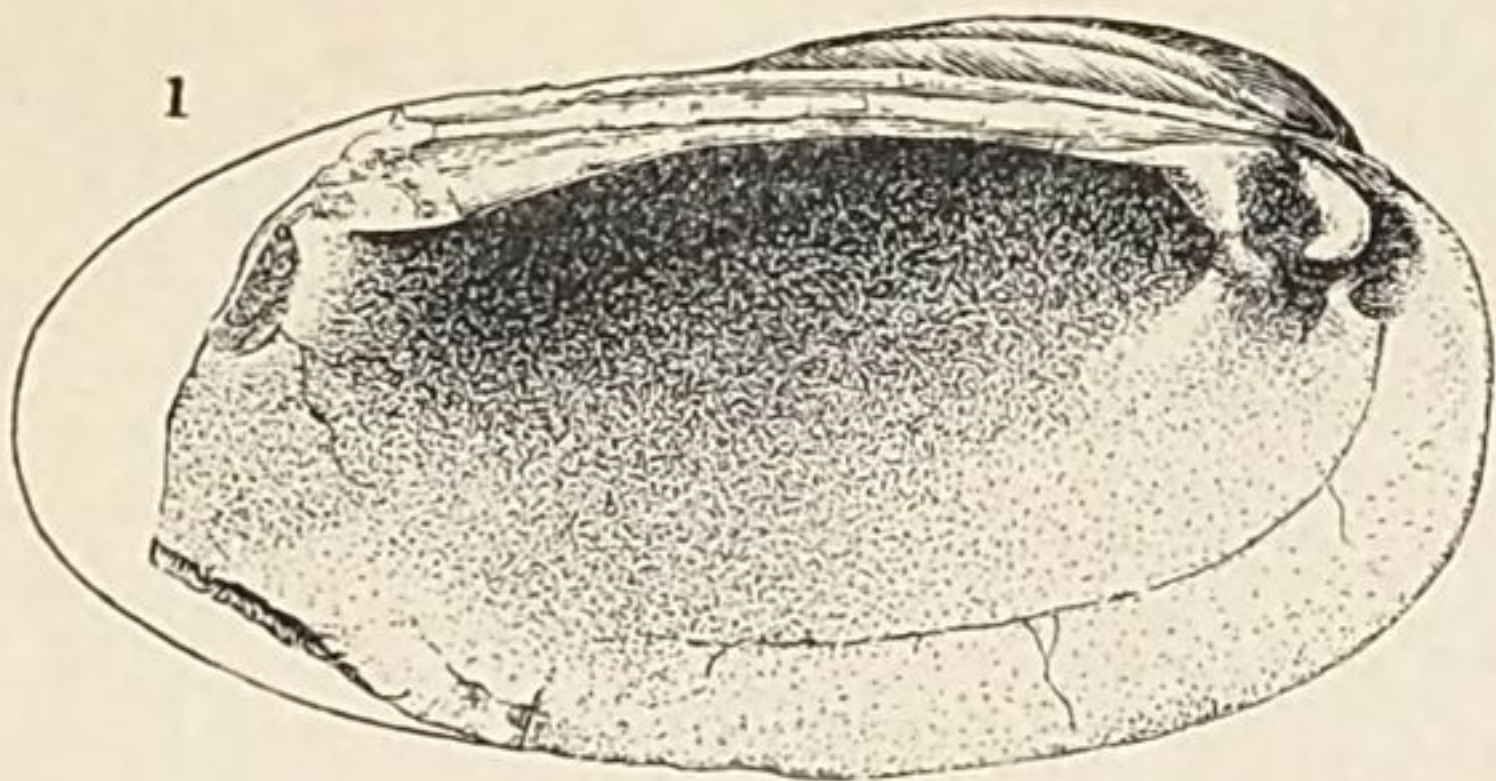
OSTREIDÆ, MYTILIDÆ, AND UNIONIDÆ.

PLATE III.

PLATE III.

UNIO VETUSTUS (p. 35).

- Fig. 1. Interior view of a left valve.
 - Fig. 2. Exterior view of a right valve.
 - Fig. 3. Dorsal view.
 - Fig. 4. Exterior view of a large, broad left valve.
- All natural size.



UNIONIDÆ.

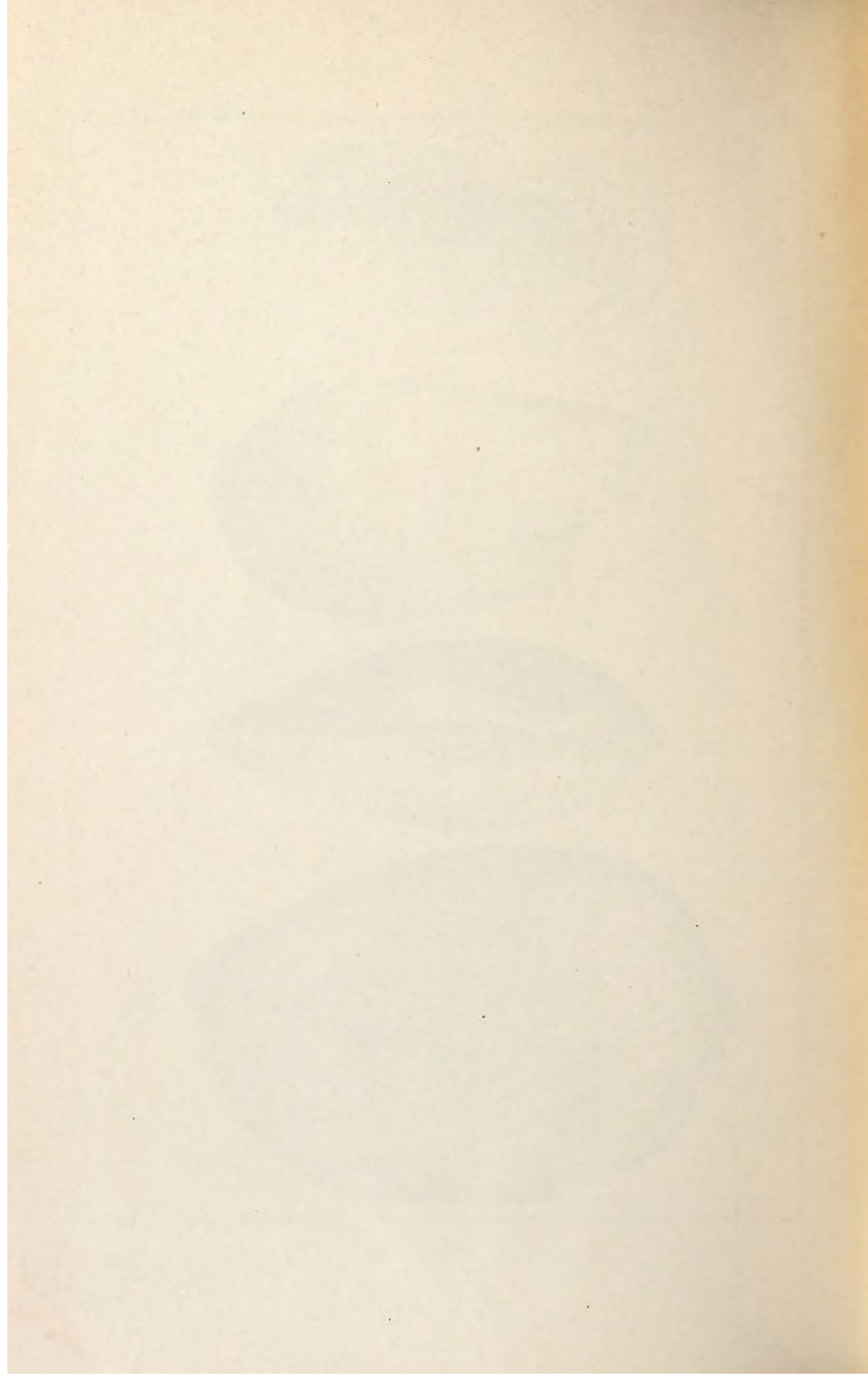


PLATE IV.

PLATE IV.

CORBICULA DURKEEI (p. 36).

- Figs. 1, 2. Lateral views.
Fig. 3. Front view.
Fig. 4. Dorsal view.

CORBULA PYRIFORMIS (p. 38).

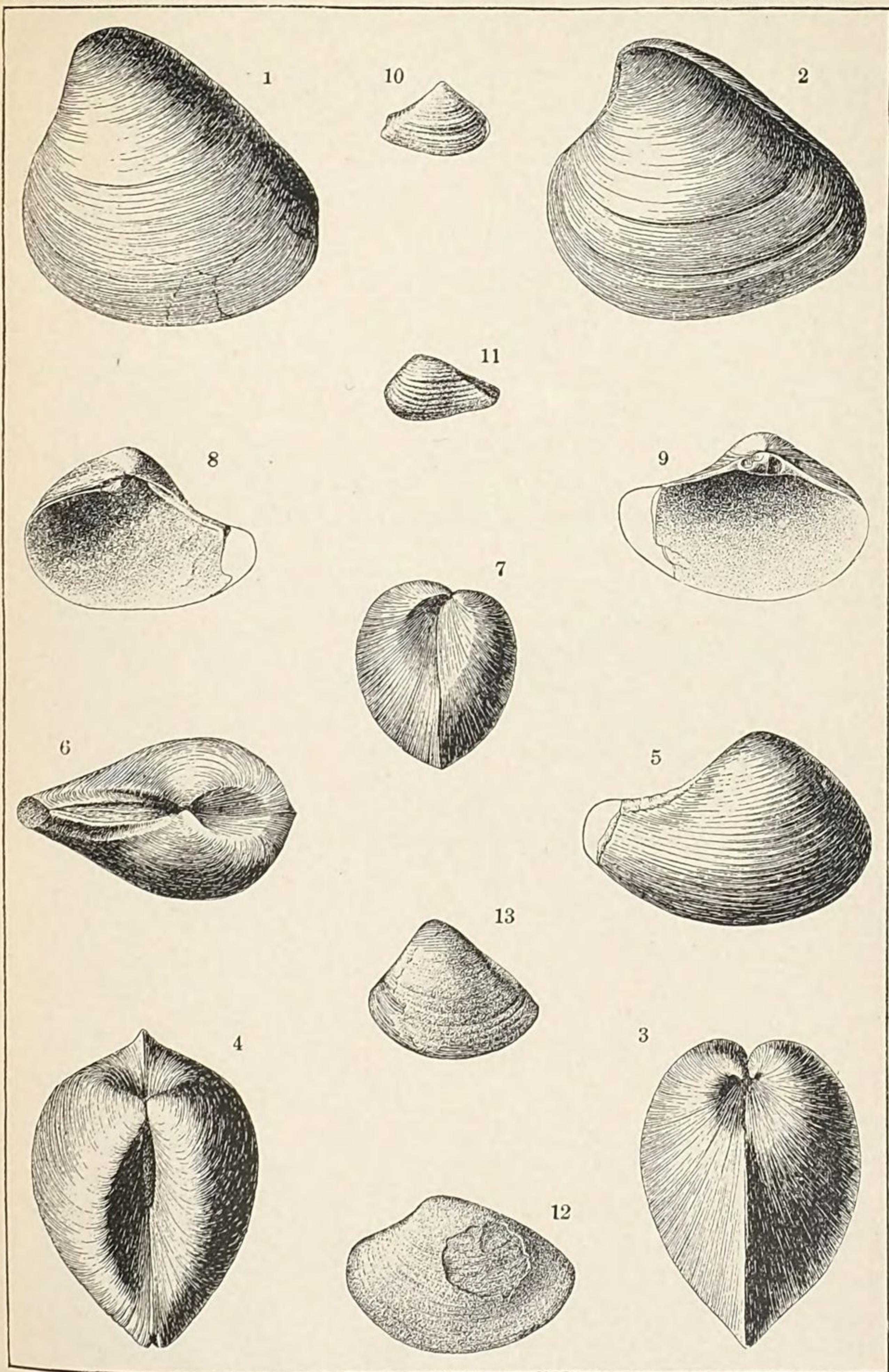
- Figs. 5, 6, 7. Lateral, dorsal, and front views, respectively, of a typical example.
Fig. 8. Interior view of a right valve.
Fig. 9. Interior view of a left valve.

CORBULA ENGELMANNI (p. 40).

- Fig. 10. Lateral view of a right valve.
Fig. 11. Lateral view of a left valve.

CORBULOMYA TAUSCHII (p. 40).

- Fig. 12. Lateral view of the left valve of the type specimen.
Fig. 13. Similar view of a left valve, probably belonging to this species.
All of natural size.



CYRENIDÆ AND CORBULIDÆ.

PLATE V.

PLATE V.

AURICULA NEUMAYRI (p. 41).

Fig. 1. Apertural view; enlarged.

MELAMPUS CLARKII (p. 42).

Fig. 2. Apertural view; enlarged.

Fig. 3. Similar view of an imperfect specimen; enlarged.

RHYTOPHORUS PRISCUS (p. 43).

Fig. 4. Apertural view; natural size (after Meek).

Fig. 5. Opposite view of the same specimen (after Meek).

RHYTOPHORUS MEEKII (p. 43).

Fig. 6. Apertural view of a large specimen; natural size.

Fig. 7. Opposite view of another example; natural size.

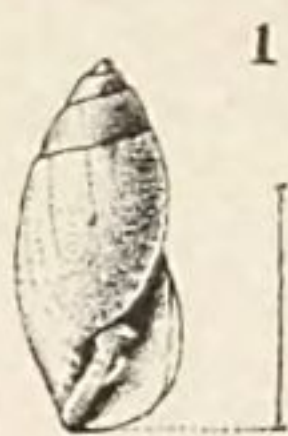
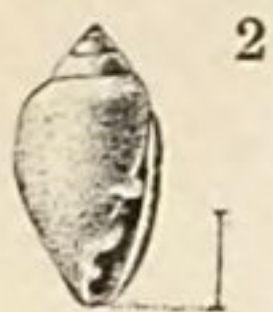
TORTACELLA HALDEMANI (p. 44).

Fig. 8. Lateral view of a typical example; enlarged.

Fig. 9. Apertural view of a more slender example; enlarged.

Fig. 10. Apertural view of an imperfect example; enlarged.

Figs. 11, 12. Copies of the figures originally published, but which did not show the columella folds.



AURICULIDÆ.

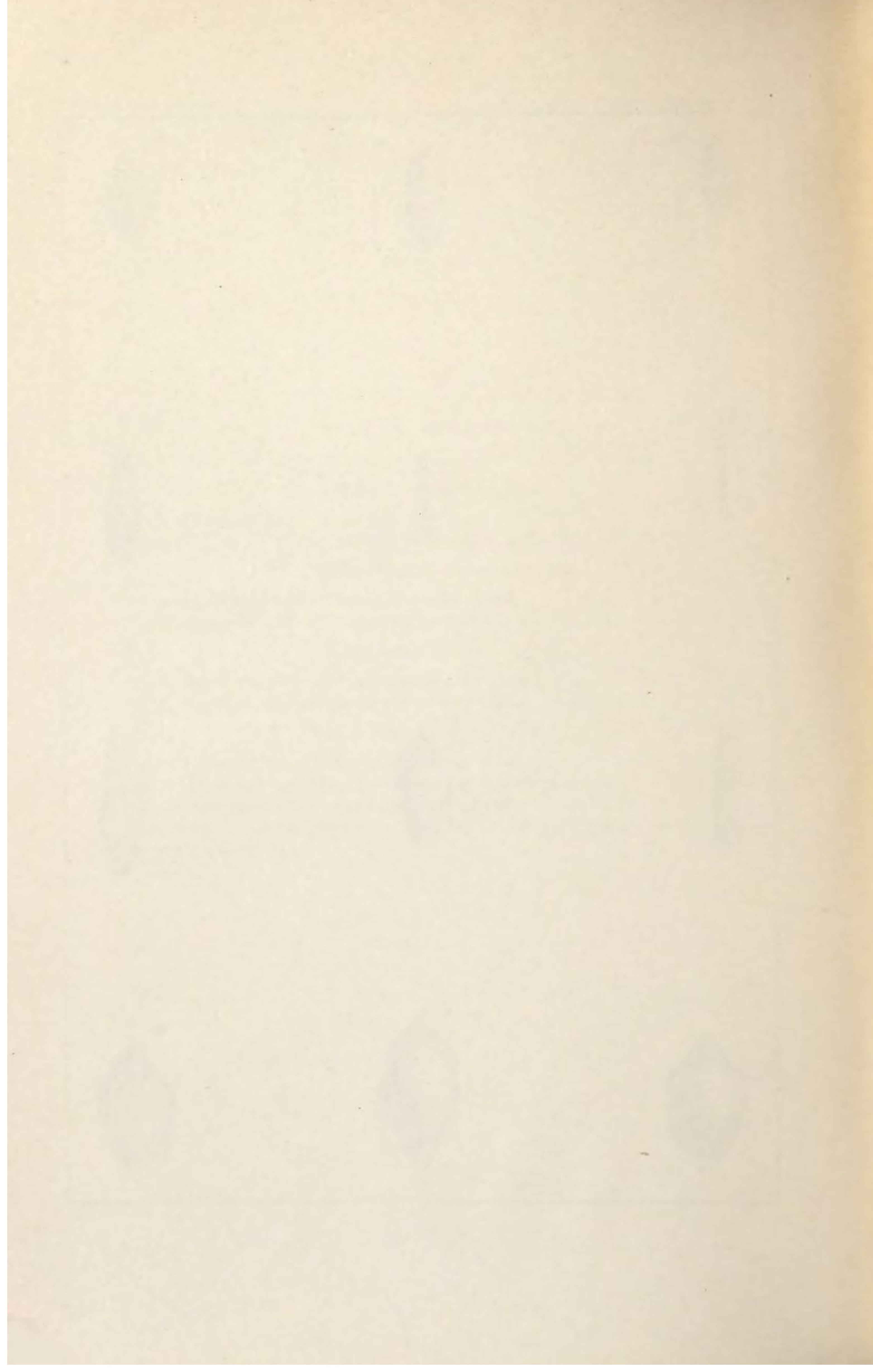


PLATE VI.

PLATE VI.

LIMNÆA NITIDULA (p. 45).

Figs. 1, 2. Copies of Mr. Meek's unpublished figures; enlarged.

Fig. 3. Apertural view of one of Mr. Meek's type specimens; natural size.

PLANORBIS (GYRAULUS) PRÆCURSORIS (p. 46).

Figs. 4, 5. Apical views.

Fig. 6. Umbilical view.

Fig. 7. Peripheral view, showing aperture.

All enlarged.

PHYSA USITATA (p. 47).

Fig. 8. Lateral view of a type specimen.

Fig. 9. Lateral view of another type specimen, partially crushed.

Both natural size.

NERITINA NATICIFORMIS (p. 49).

Figs. 10, 11. Upper and under views of separate examples; natural size.

Fig. 12. Lateral view of one of the original type specimens; much enlarged.

HELIX? ———? (p. 48).

Fig. 13. Lateral view of the only discovered example; much enlarged.

TORNATELLINA? ISOCLINA (p. 48).

Fig. 14. Lateral view of the type specimen; enlarged.

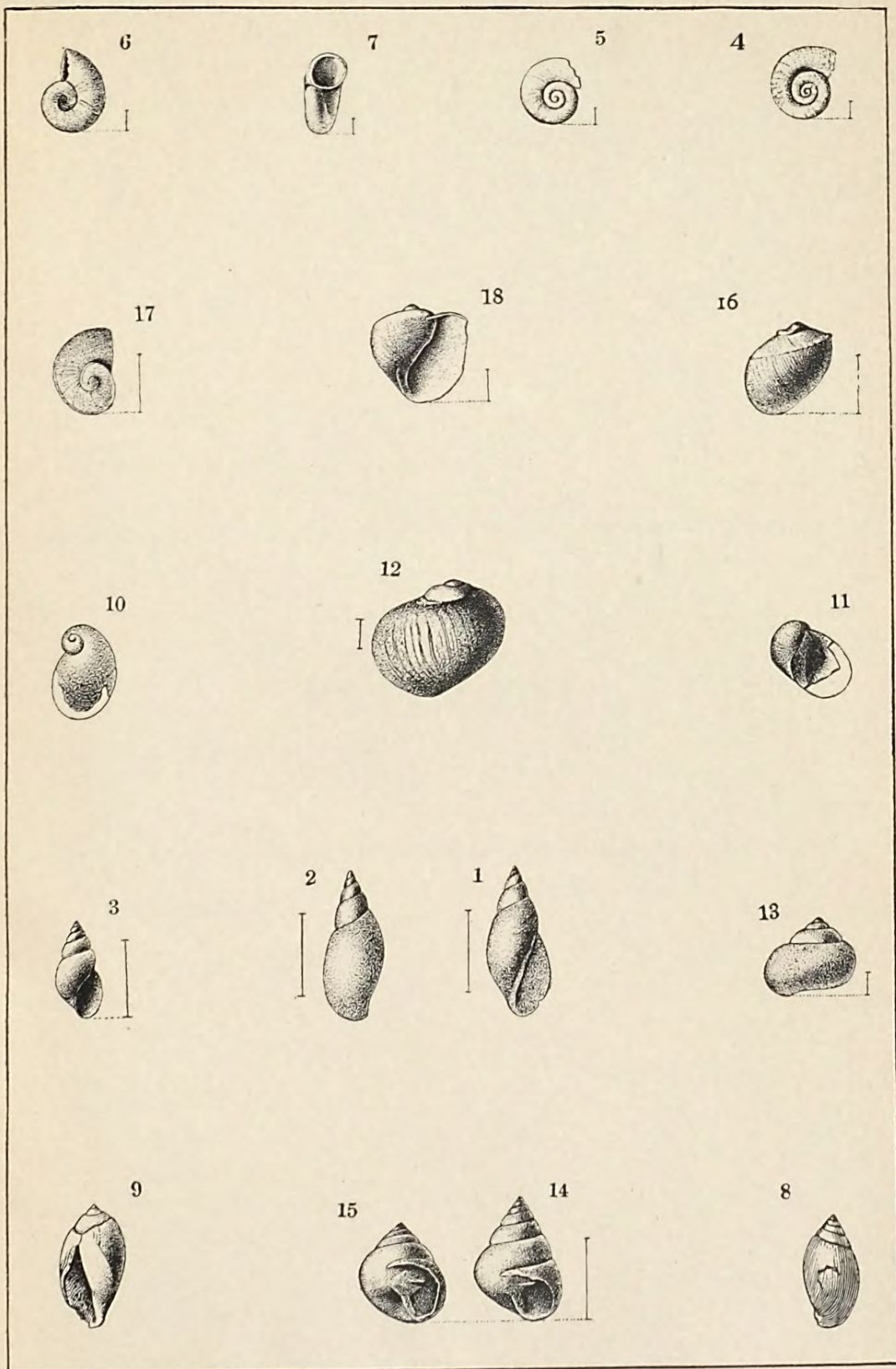
Fig. 15. Foreshortened view of the same specimen, showing the small umbilicus.

NERITINA STANTONI (p. 49).

Fig. 16. Lateral view of an adult example; enlarged.

Fig. 17. Apical view of the same, showing that the specimen has been slightly compressed.

Fig. 18. Lateral view of a young example; much enlarged.



LIMNEIDÆ, PHYSIDÆ, NERITIDÆ AND HELICIDÆ(?).

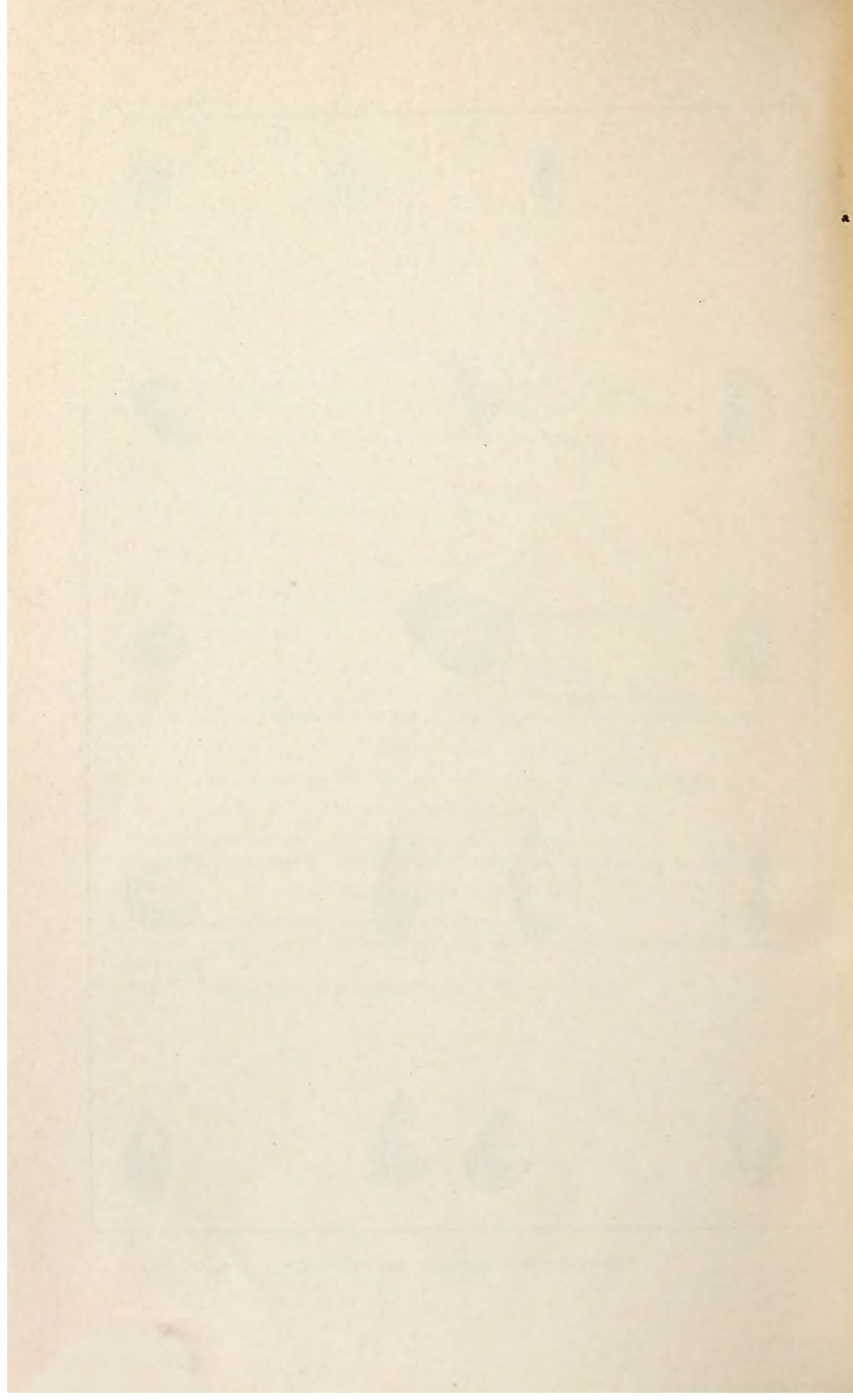


PLATE VII.

Bull. 128—7

PLATE VII.

PACHYMELANIA CLEBURNI (p. 51).

Figs. 1, 2. Lateral views of typical examples; natural size.

Fig. 3. Similar views of an example showing obsolescence of longitudinal varices.

PACHYMELANIA CHRYSALLOIDEA (p. 52).

Figs. 4, 5. Lateral views of the type specimens; natural size.

PACHYMELANIA CHRYSALIS (p. 51).

Figs. 6, 7. Lateral views of typical examples; enlarged.

Figs. 8, 12, 13. Possibly varieties; natural size.

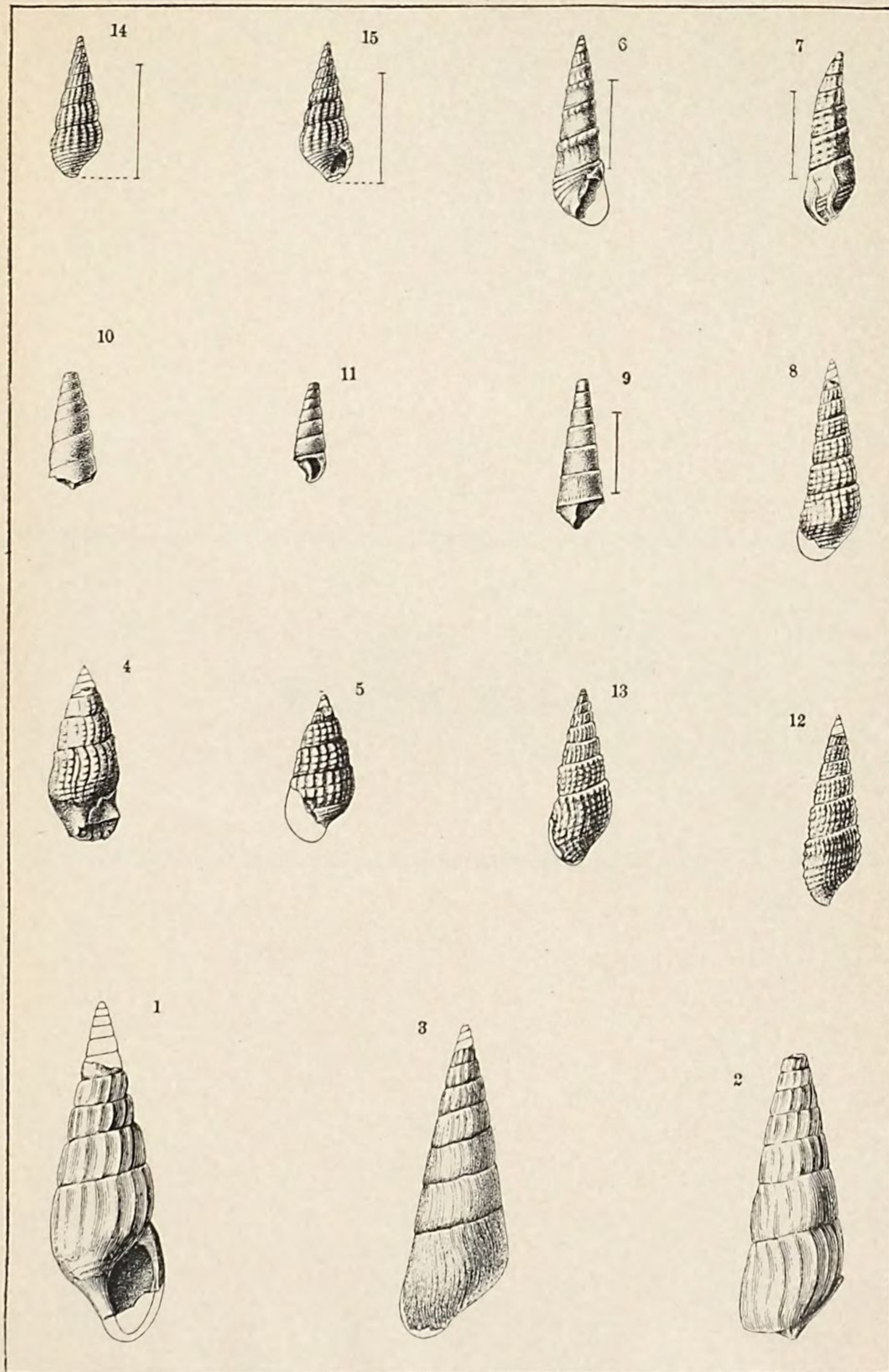
PACHYMELANIA? MACILENTA (p. 54).

Fig. 9. Lateral view of type specimen; enlarged.

Figs. 10, 11. Possibly varieties; natural size.

PACHYMELANIA TURRICULA (p. 53).

Figs. 14, 15. Lateral views of the type specimen; enlarged.



MELANIIDÆ.

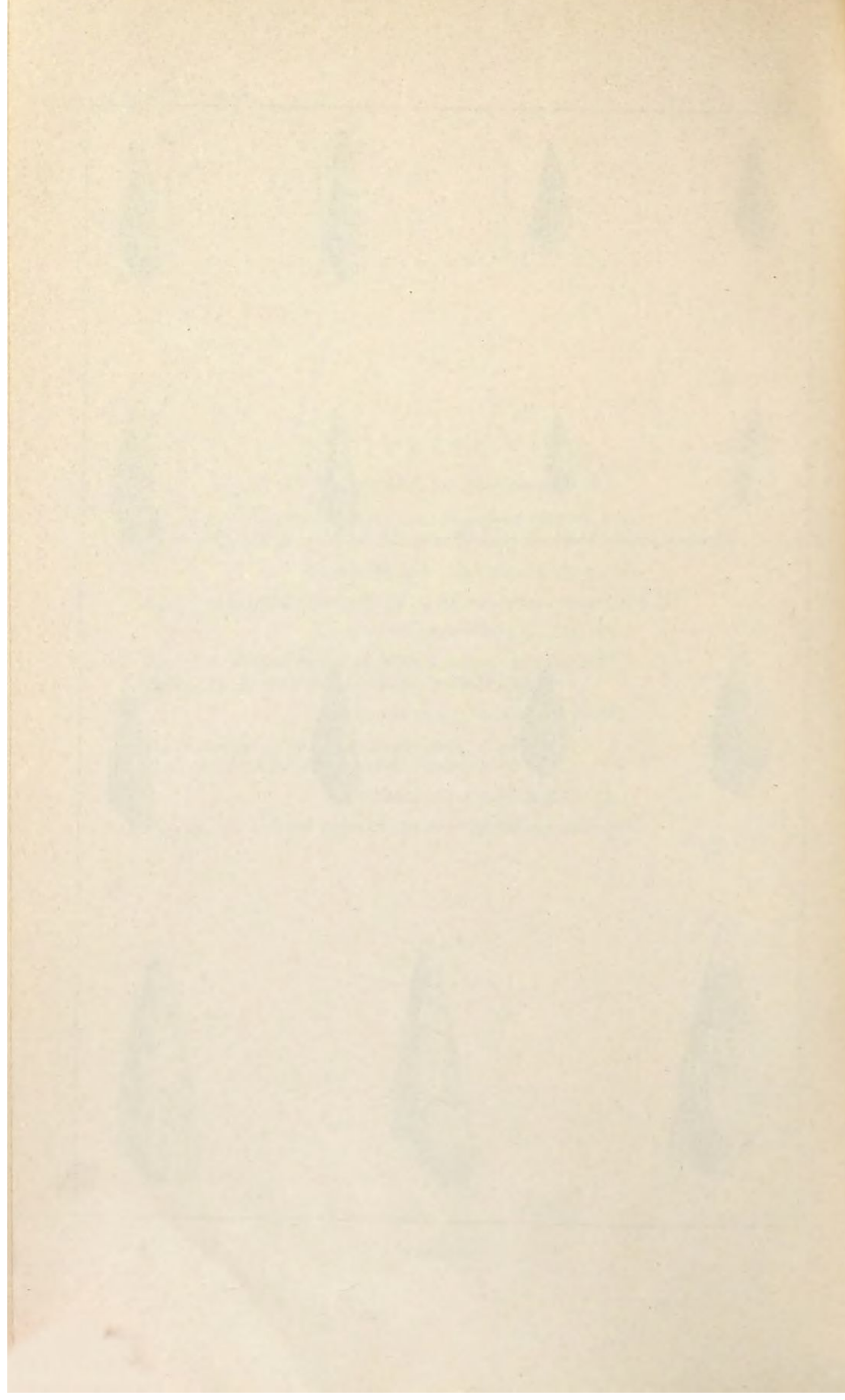


PLATE VIII.

PLATE VIII.

PYRGULIFERA HUMEROSA (p. 55).

Figs. 1, 2. Lateral views of Mr. Meek's type specimen.

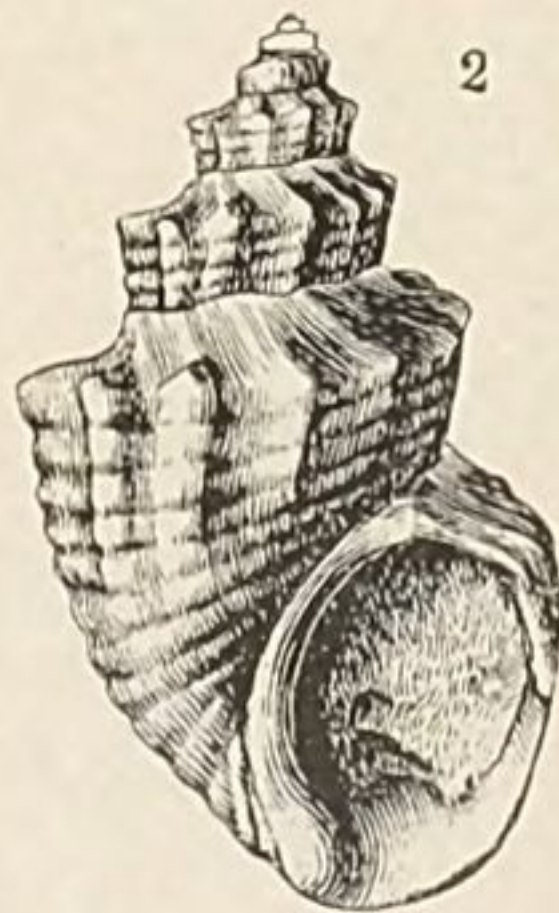
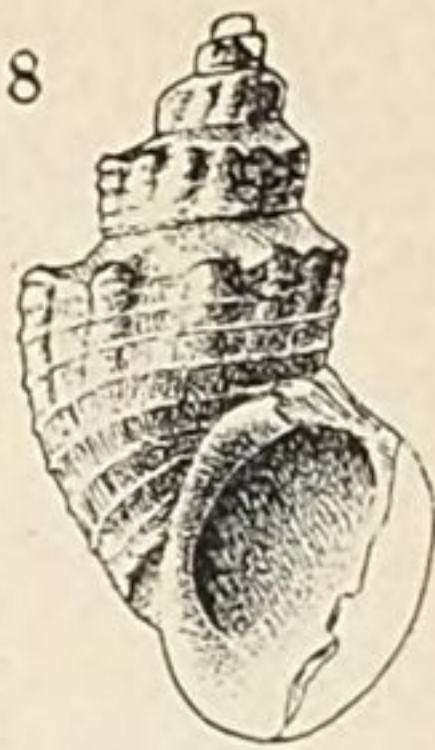
Figs. 3, 4, 5, 6. Lateral views of typical forms.

Figs. 7, 8. Lateral views of an unusually elongate example.

Figs. 9, 10. Two examples showing an umbilicate fissure.

Fig. 11. A very young example; enlarged.

All natural size.



MELANIIDÆ.

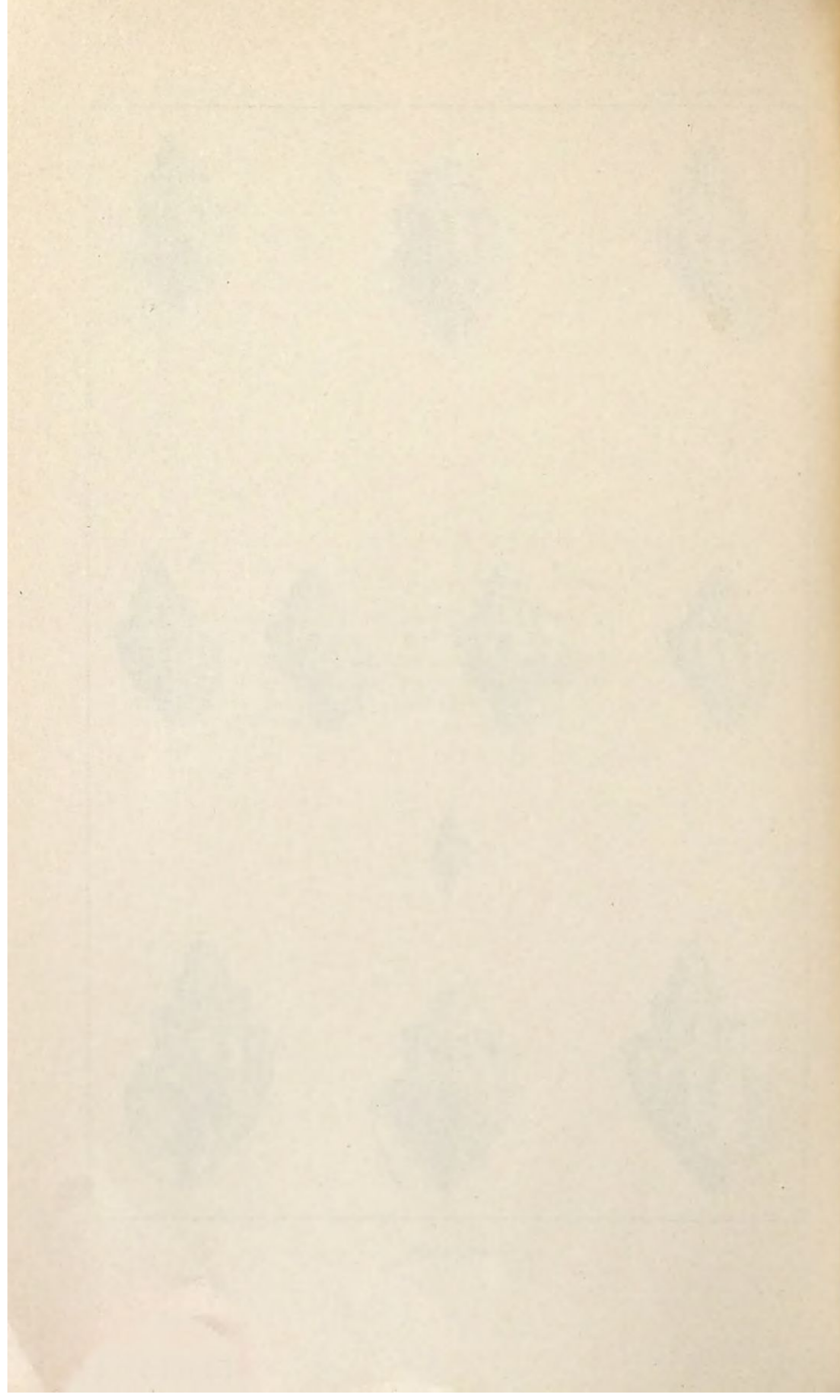


PLATE IX.

PLATE IX.

PYRGULIFERA STANTONI (p. 57).

Figs. 1, 2. Lateral views of typical examples.

Fig. 3. A similar view of another example.

PYRGULIFERA HUMEROSA (p. 55).

Fig. 4. Lateral view of an example having the volutions more than usually rounded and the nodules obsolete.

Fig. 5. Lateral view of another example showing a somewhat similar rounding of the volutions of the spire.

Fig. 6. Another example having a prominent shoulder to the volutions, but only a slight development of nodules.

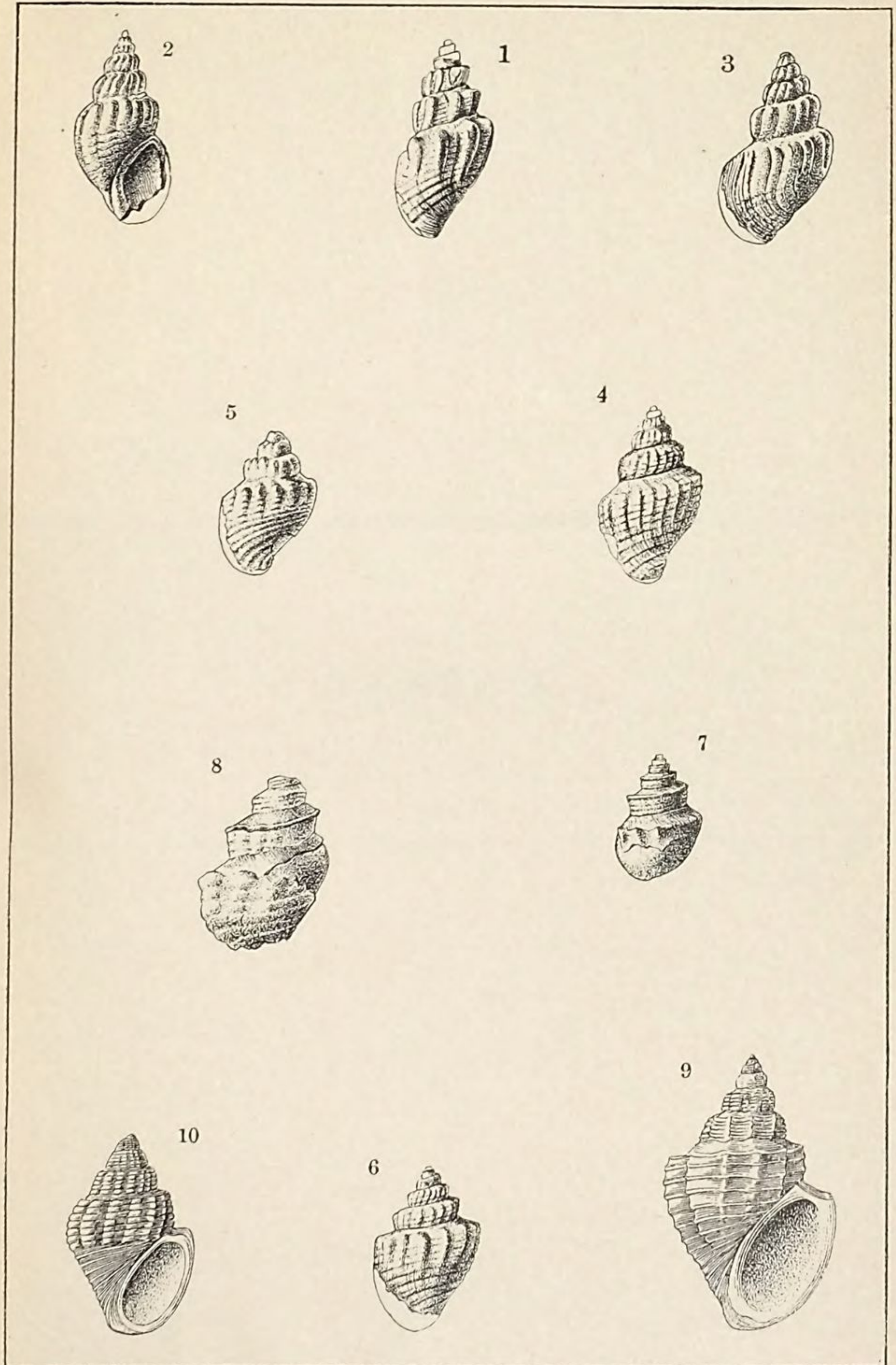
Figs. 7, 8. Two examples showing absence of longitudinal varices and a continuous carina at the humeral angle.

PYRGULIFERA (PARAMELANIA) DAMONI.

Fig. 9. A copy of Mr. Smith's original figure. (For comparison.)

PYRGULIFERA (PARAMELANIA) CRASSIANGULATA.

Fig. 10. A copy of Mr. Smith's original figure. (For comparison.)
All of natural size.



MELANIIDÆ.

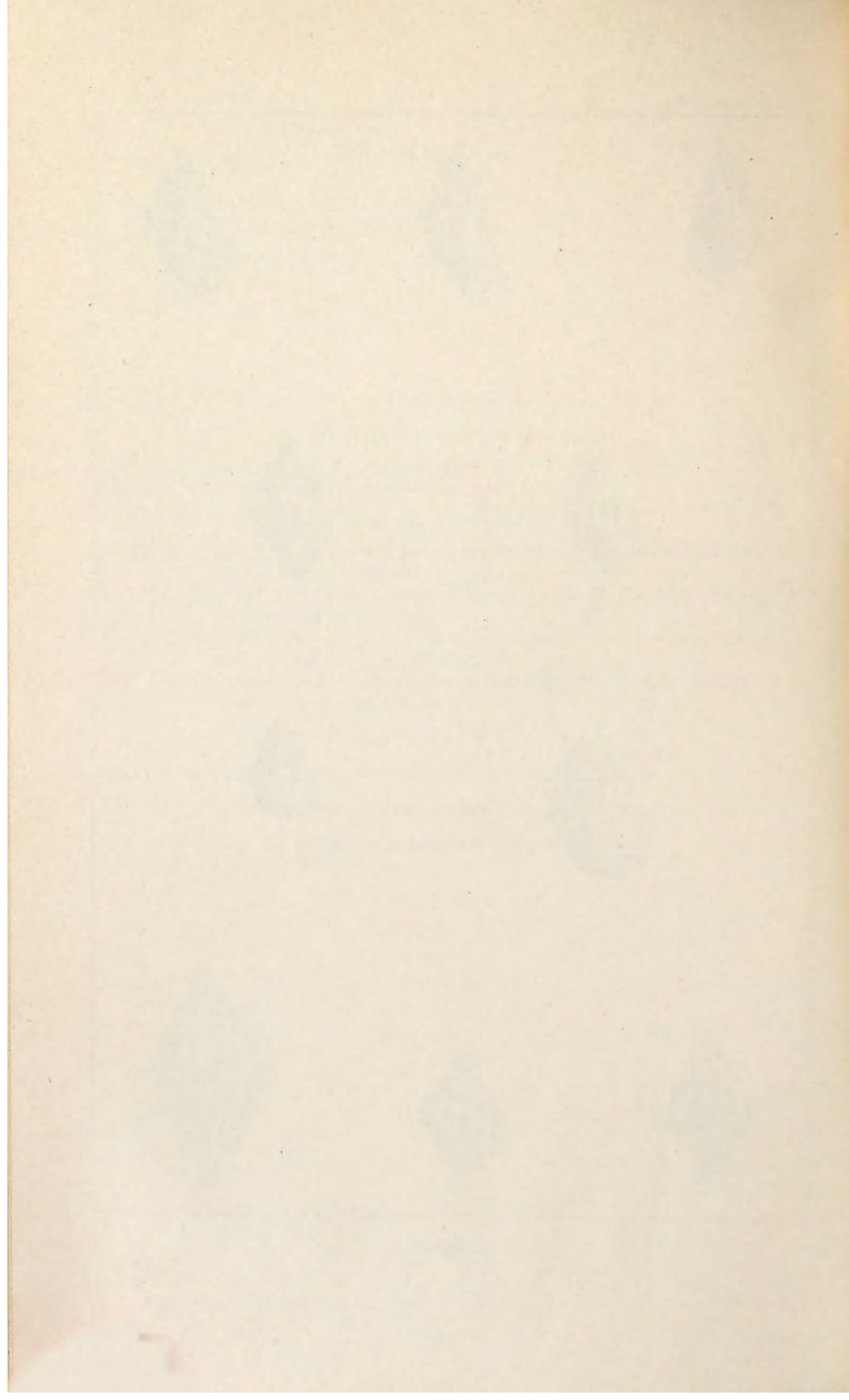


TABLE V

L A T E X.

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PLATE X.

VIVIPARUS COUESI (p. 59).

Fig. 1. Lateral view of the type specimen; natural size.

CAMPELOMA MACROSPIRA (p. 60).

Figs. 2, 3. Lateral views of the type specimen; natural size.

LIOPLAX? ENDLICHII (p. 60).

Figs. 4, 5. Lateral views of the two type specimens.

Fig. 6. Lateral view of the apical portion of a specimen possibly belonging to this species.

All natural size.

CHARYDROBIA STACHEI (p. 58).

Fig. 7. Apertural view of a typical example.

Figs. 8, 9. Lateral views of two other examples.

All enlarged.

BYTHINELLA LATENTIS (p. 58).

Figs. 10, 11. Lateral views of the type specimens; much enlarged.

HYDROBIA OCCULTA (p. 57).

Figs. 12, 13. Lateral views of the type specimens; much enlarged.

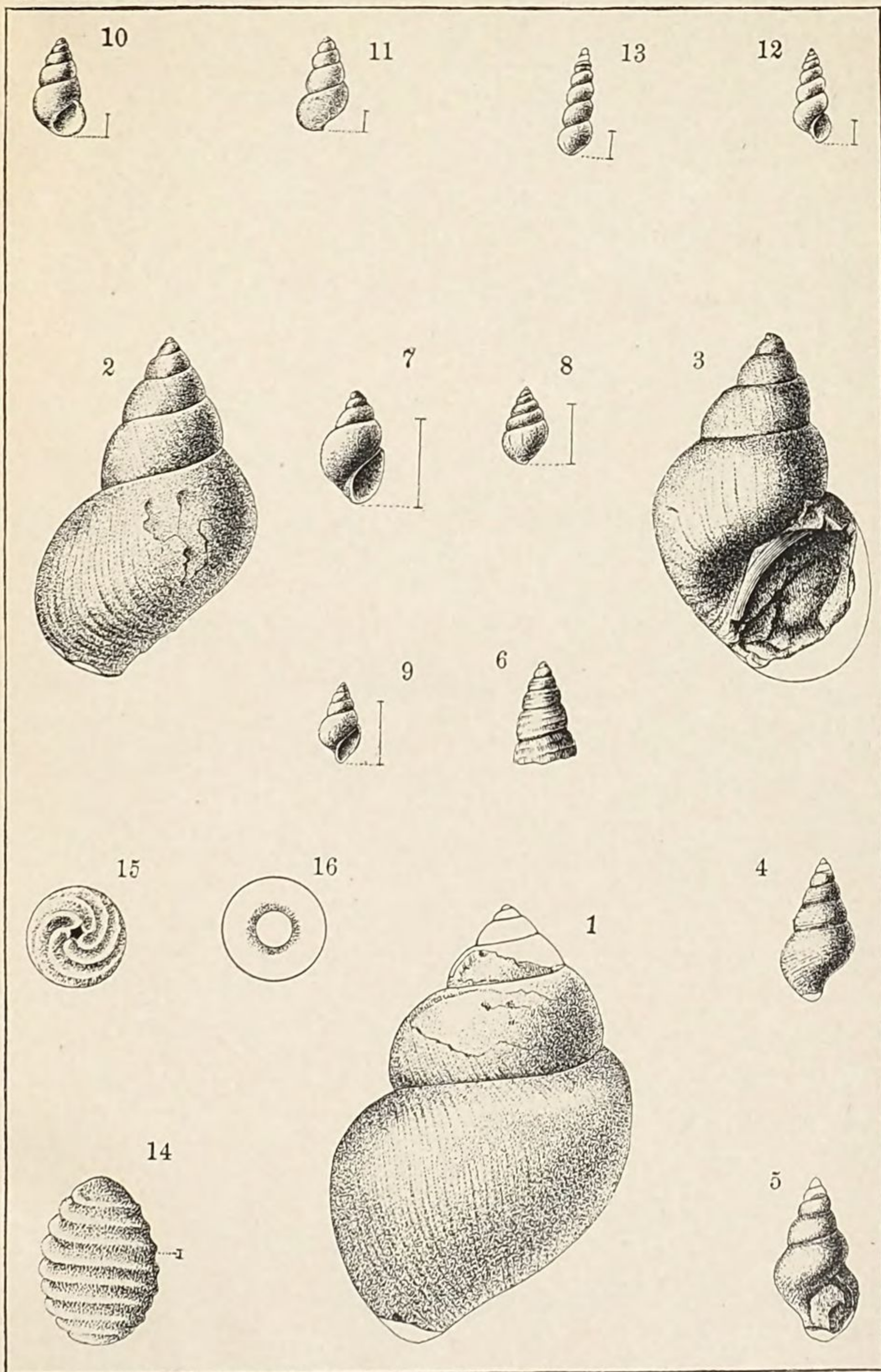
CHARA STANTONI (p. 63).

Fig. 14. Lateral view of a nutlet.

Fig. 15. Basal view of the same.

Fig. 16. Transverse section.

All greatly enlarged.



VIVIPARIDÆ, RISSOIDÆ, AND CHARA.

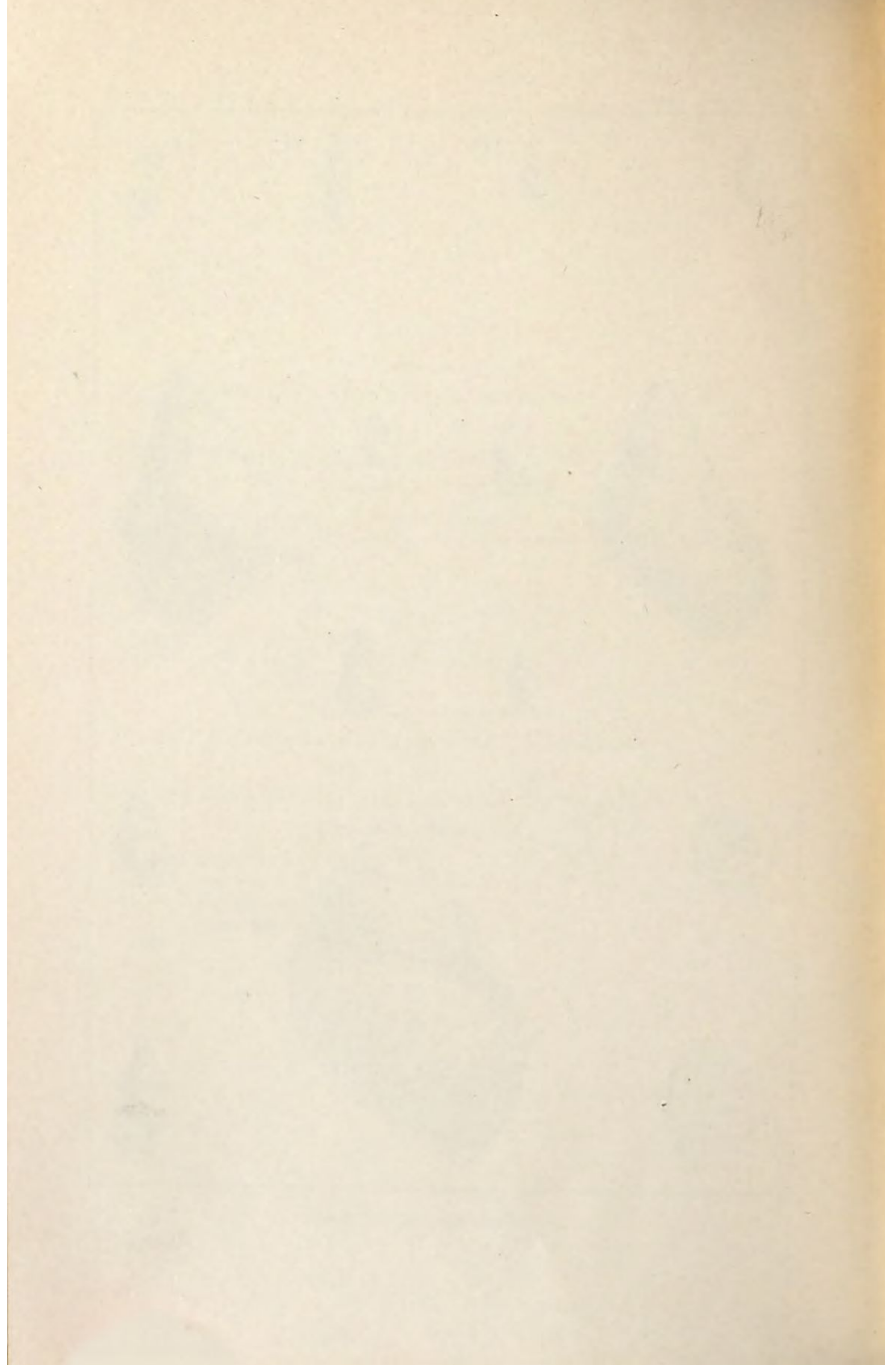


PLATE XI.

P L A T E X I.

METACYPRIS CONSOBRINA (p. 62).

Fig. 1. *a*, Carapace, left valve shown; *b*, edge view; *c*, end view.

METACYPRIS SUBCORDATA (p. 62).

Fig. 2. *a*, Left valve shown; *b*, edge view; *c*, end view.

METACYPRIS CUNEIFORMIS (p. 62).

Fig. 3. *a*, Right valve shown; *b*, edge view; *c*, end view.

CYTHERIDEA TRUNCATA (p. 62).

Fig. 4. *a*, Left valve shown; *b*, ventral edge.

CYPRIDEA TUBERCULATA VAR. WYOMINGENSIS (p. 62).

Fig. 5. *a*, Right valve shown; *b*, ventral edge.

Fig. 6. *a*, Left valve shown; *b*, ventral edge.

CYTHERIDEA TENUIS (p. 62).

Fig. 7. *a*, Left valve shown; *b*, edge view.

POTAMOCYPRIS AFFINIS (p. 62).

Fig. 8. *a*, Right valve shown; *b*, ventral edge.

METACYPRIS SIMPLEX (p. 62).

Fig. 9. *a*, Right valve shown; *b*, edge view; *c*, end view.

CYPRIS PURBECKENSIS (p. 62).

Fig. 10. *a*, Carapace, right valve shown; *b*, edge view.

CYTHERIDEIS ÆQUALIS (p. 62).

Fig. 11. *a*, Carapace, left valve shown; *b*, edge view.

CYTHERIDEIS IMPRESSA (p. 62).

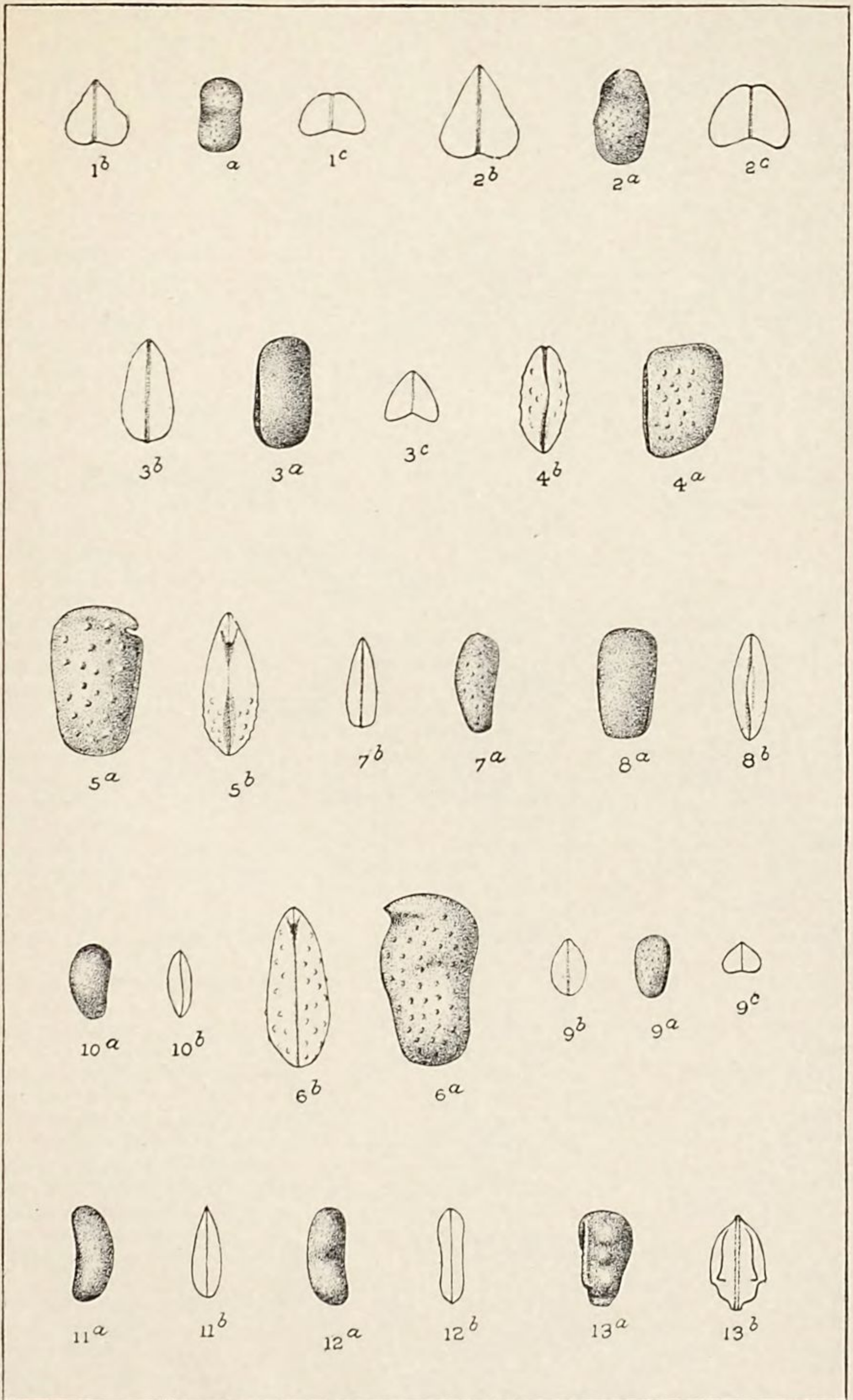
Fig. 12. *a*, Right valve shown; *b*, edge view.

CYTHERE MONTICULA (p. 62).

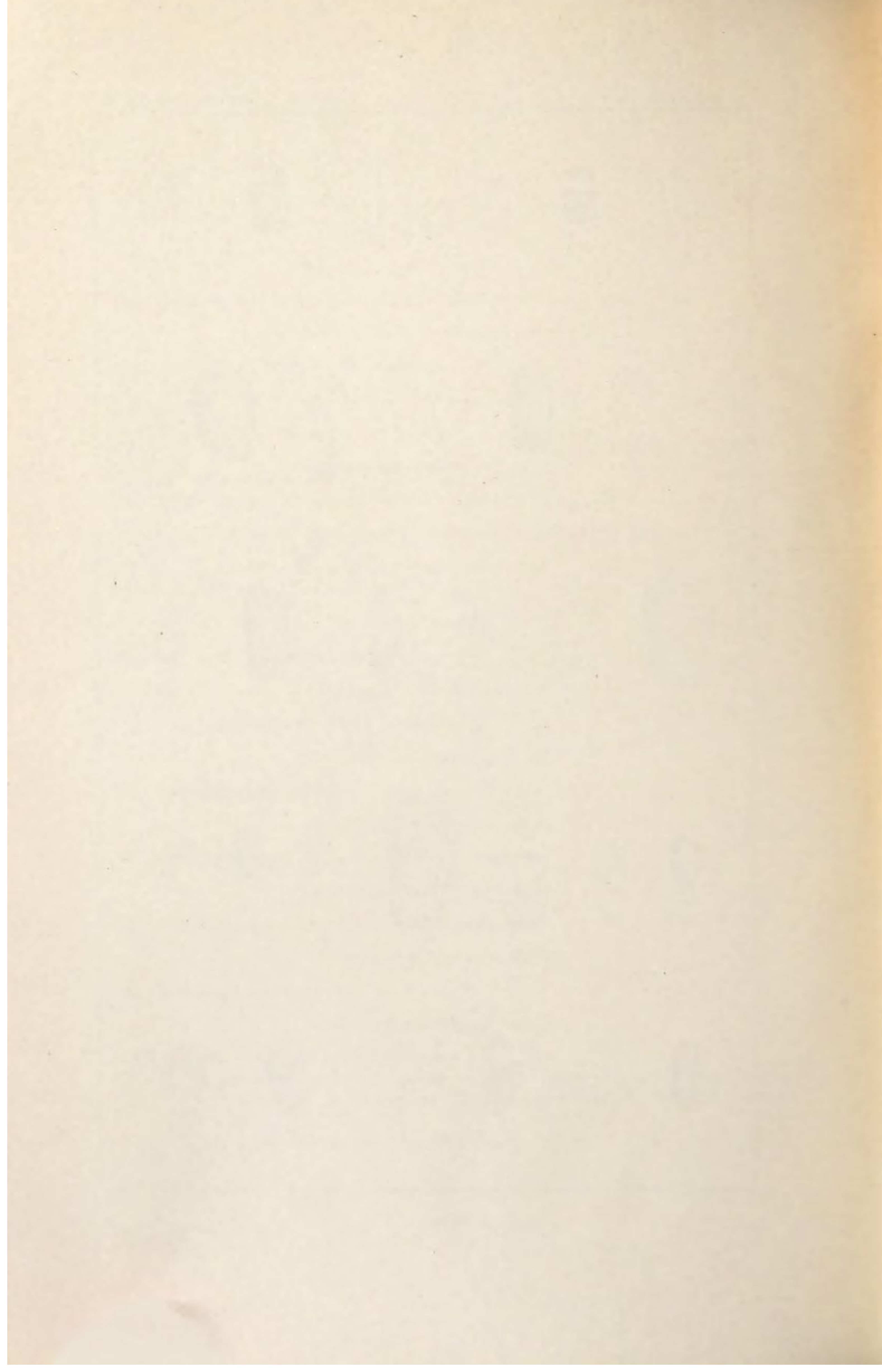
Fig. 13. *a*, Left valve shown; *b*, edge view.

Figures and explanations copied from Professor Jones's original publication: *Geol. Mag.*, new ser., Decade III, Vol. X, pp. 385-391, pl. xv, London, 1893.

All figures enlarged 20 diameters.



OSTRACODA.



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OF THE

UNITED STATES

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No. 129

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TO THE DIRECTOR OF THE
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WASHINGTON, D. C., April, 1895.

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1895

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

EARTHQUAKES IN CALIFORNIA

IN

1894

BY

CHARLES D. PERRINE

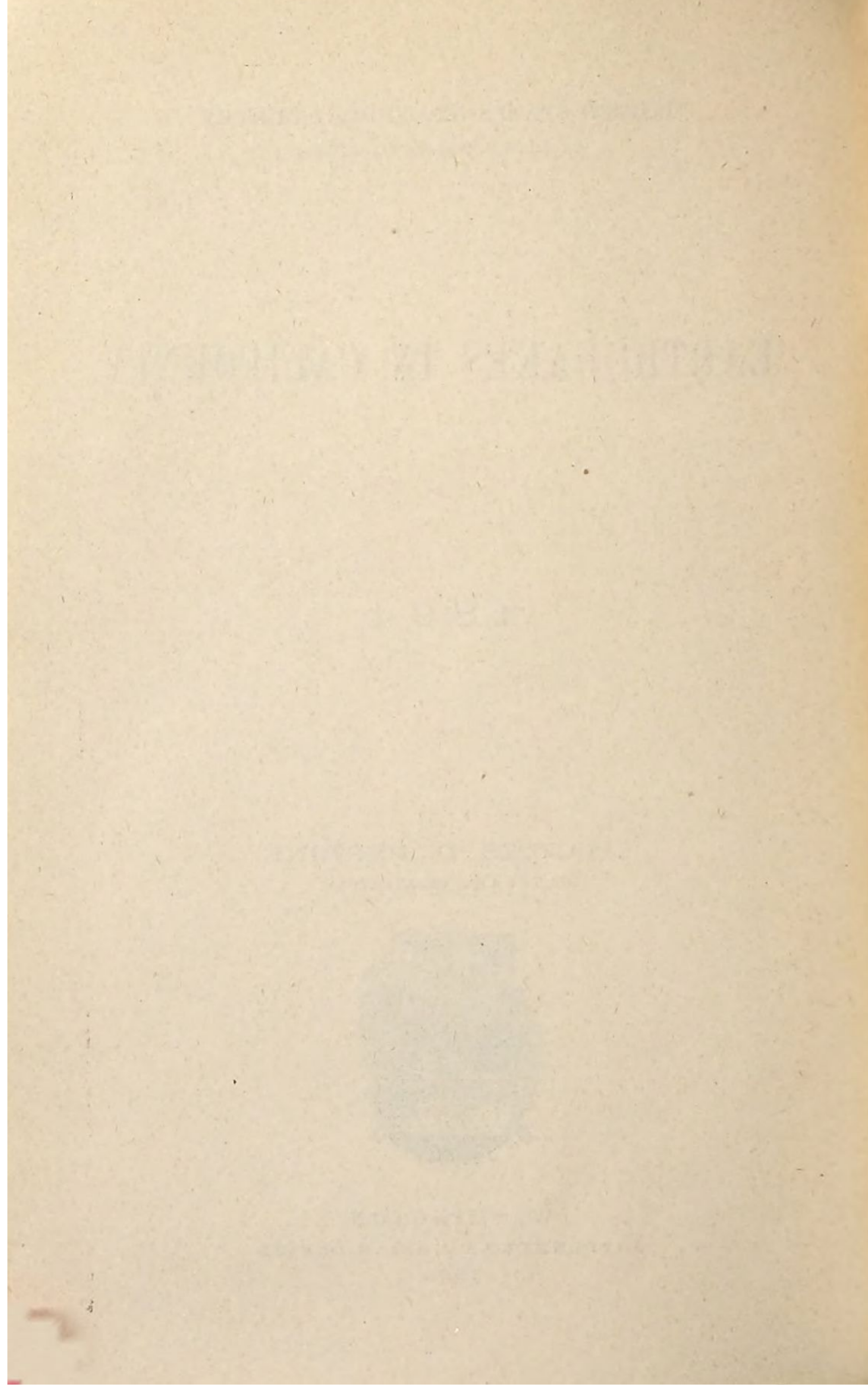
OF THE LICK OBSERVATORY



WASHINGTON

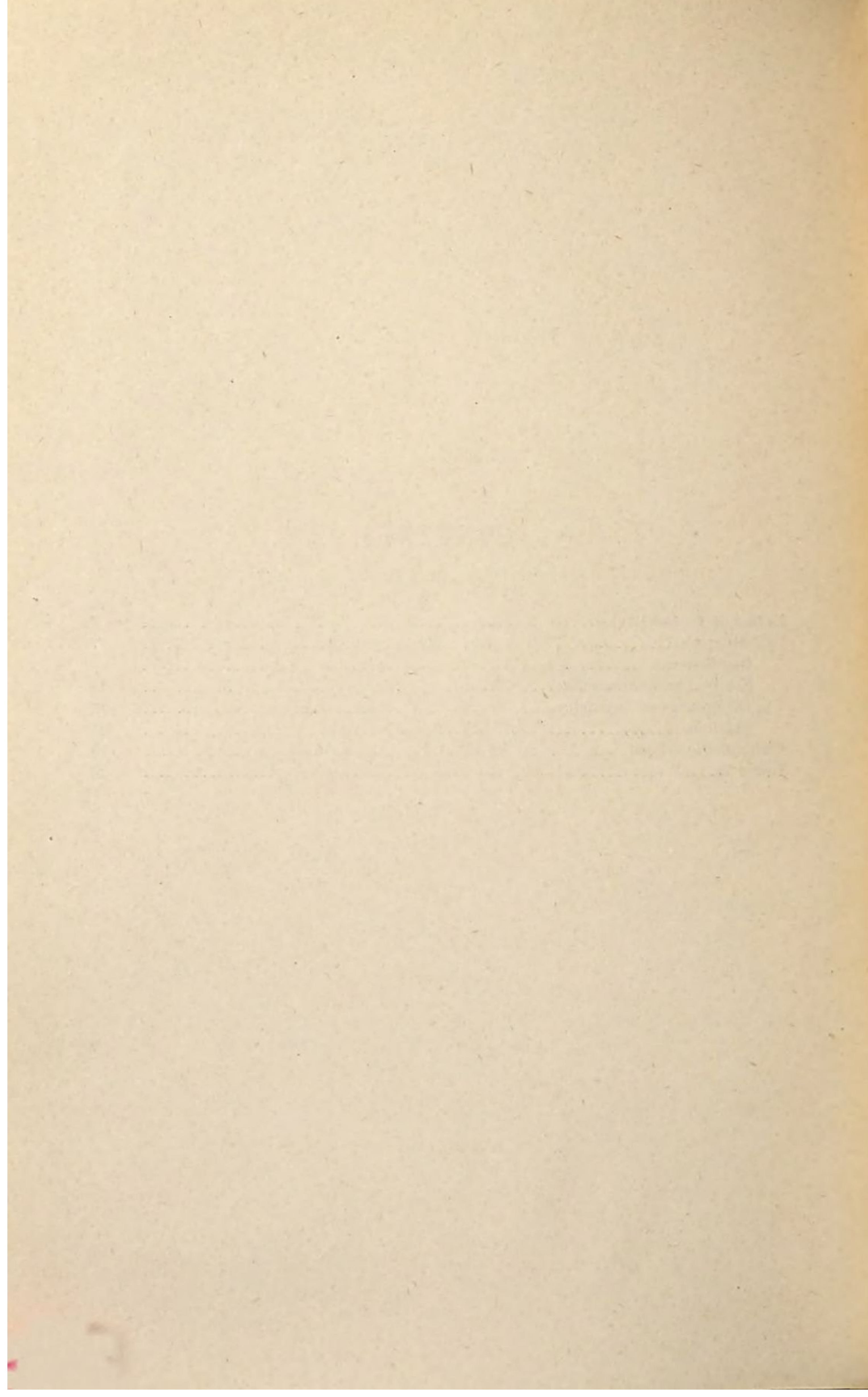
GOVERNMENT PRINTING OFFICE

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LETTER OF TRANSMITTAL

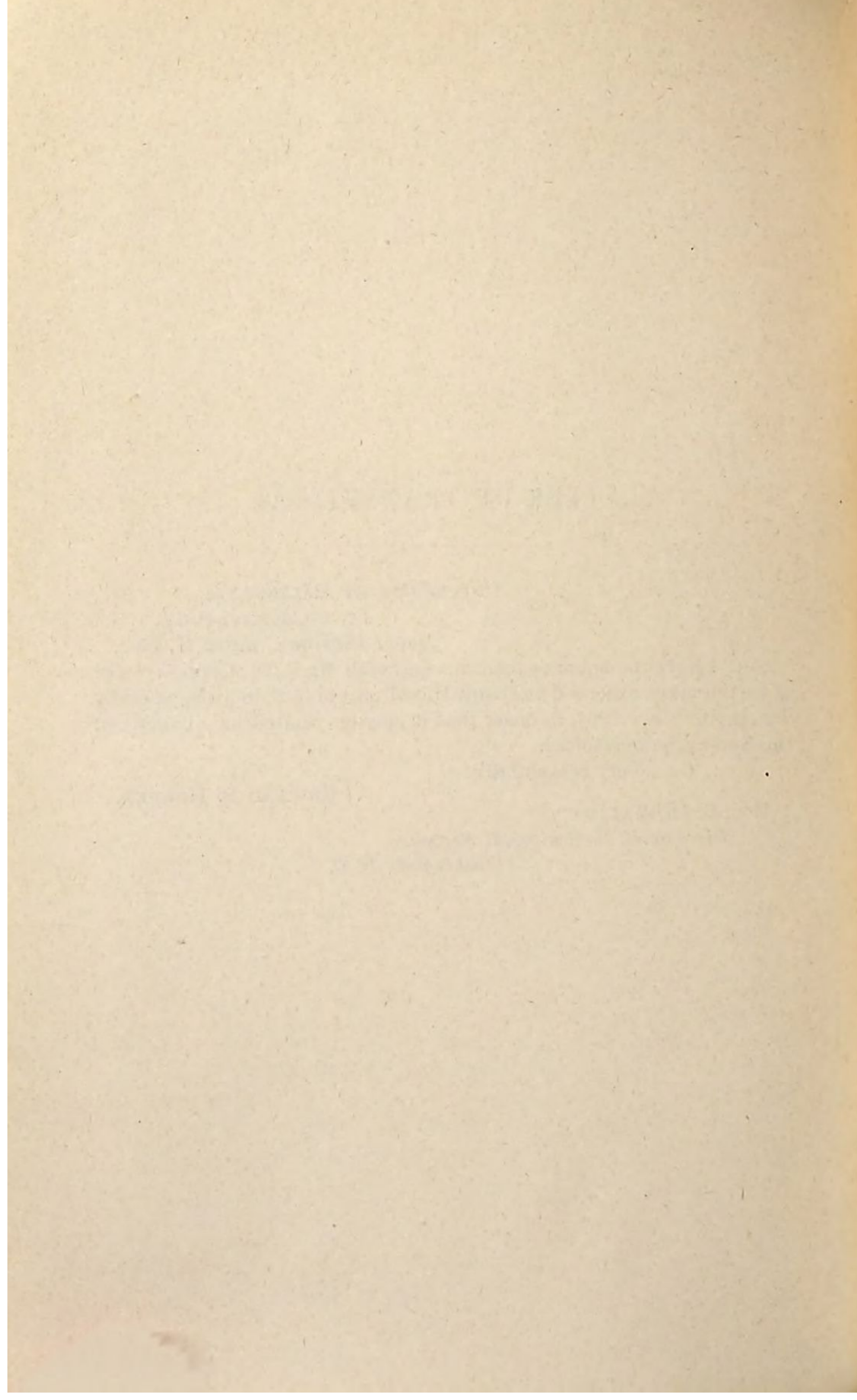
UNIVERSITY OF CALIFORNIA,
LICK OBSERVATORY,
Mount Hamilton, March 15, 1895.

SIR: I have the honor to transmit herewith Mr. C. D. Perrine's report of earthquakes observed at Mount Hamilton and in California generally during the year 1894, in order that it may be printed as a bulletin of the Survey, as heretofore.

Very respectfully

EDWARD S. HOLDEN.

Hon. C. D. WALCOTT,
Director U. S. Geological Survey,
Washington, D. C.



EARTHQUAKES IN CALIFORNIA IN 1894.

By CHARLES D. PERRINE.

INTRODUCTION.

The following report is a continuation of similar records,¹ and brings the list up to the end of the year 1894. It contains accounts of all the shocks observed or felt on Mount Hamilton and all those reported to the Lick Observatory by letter, as well as newspaper reports of earthquakes occurring in the State during that year. Many newspapers have been examined, and this bulletin is largely made up from their reports. Some may have escaped notice.

It has been the object especially to record earthquakes occurring in California, but a number of shocks are here recorded which do not properly belong in a record of California earthquakes, which have been included for fear they may have escaped other compilers. The records of the United States Weather Bureau and of the United States Light-House Board, together with the present list, will afford a fairly complete account of the California earthquakes of 1894.

INSTRUMENTS.

The instruments used for recording earthquakes on Mount Hamilton are described in Publications of the Lick Observatory, Vol. I, page 82. The largest and most complete instrument records the three components of the earth's motion, viz, north and south, east and west, and vertical, separately, on a smoked glass plate, which is started by the preliminary tremors of the earthquake and rotates in about three minutes, the edge of the plate being graduated into seconds at the same time by a clock, which also serves to record the time of occurrence of the shock. This instrument has been called the Ewing seismograph in the notes.

¹ List of recorded earthquakes in California, Lower California, Oregon, and Washington Territory (1769 to 1888), Sacramento, State Printing Office, 1887, 8vo. Earthquakes in California in 1888; American Journal of Science, Vol. XXXVII, May, 1889. Earthquakes in California in 1889; Bulletin of the U. S. Geological Survey, No. 68, 1890. Earthquakes in California in 1890 and 1891; Bulletin of the U. S. Geological Survey, No. 95, 1892. Earthquakes in California in 1892; Bulletin of the U. S. Geological Survey, No. 112, 1893.

Another simpler form consists of a heavy "duplex" pendulum adjusted to a long period of vibration, with a magnifying pointer or pen, which records on a smoked glass plate the two horizontal components of motion. The vertical component and the time are not recorded. The motion of the earth is magnified 4.0 times in the duplex seismometers.

The Observatory possesses other seismographs of various patterns, but they are not constantly in use.

SCALE OF MEASUREMENTS.

In the record made by the Ewing seismograph both horizontal components are magnified 3.3 times, and the vertical component is magnified 1.6 times. The measures of the vibrations as given in the notes are taken directly from the tracings, and therefore represent the magnified motions, unless otherwise noted.

If both the period (T) and the amplitude (a) of an earthquake wave are given, the maximum acceleration due to the impulse, which may be taken as a measure of the intensity or destructive effect of the shock, is given by the formula—

$$I = \frac{4\pi^2 a}{T^2},$$

in which the motion is assumed to be harmonic.

DIFFERENCES OF INTENSITY.

Estimates of the intensity of shocks are also given (in roman numerals inclosed in parentheses) according to the Rossi-Forel scale, which for convenience of reference is inserted below. Experience has suggested that for observations in California a few additions should be made to this scale, and these are printed here in italics. When these are in quotation marks also, they are expressions actually used in the newspapers, etc., in describing earthquake shocks whose intensity is otherwise known. The scale as amended is as accurate as anything of the kind can be.

I.

Microseismic shocks recorded by a single seismograph, or by seismographs of the same model, but not putting seismographs of different patterns in motion; reported by experienced observers only.

II.

Shock recorded by several seismographs of different patterns; reported by a small number of persons who are at rest: "*a very light shock.*"

III.

Shock reported by a number of persons who are at rest; duration or direction noted; "*a shock;*" "*a light shock.*"

IV.

Shock reported by persons in motion; shaking of movable objects, doors, and windows; cracking of ceilings; "*moderate*;" "*strong*;" "*sharp*;" (sometimes) "*light*."

V.

Shock felt generally by everyone; furniture shaken; some bells rung; *some clocks stopped*; *some sleepers waked*; "*smart*;" "*strong*;" "*heavy*;" "*severe*;" "*sharp*;" "*quite violent*."

VI.

General awakening of sleepers; general ringing of bells; swinging of chandeliers; stopping of clocks; visible swaying of trees; some persons run out of buildings; *window glass broken*; "*severe*;" "*very severe*;" "*violent*."

VII.

Overturning of loose objects; fall of plaster; striking of church bells; general fright, without damage to buildings; *nausea felt*; "*violent*;" "*very violent*."

VIII.

Fall of chimneys; cracks in the walls of buildings.

IX.

Partial or total destruction of some buildings.

X.

Great disasters; overturning of rocks; fissures in the surface of the earth; mountain slides.

The relation between the intensity (I) of a shock as determined by the formula already given and the numbers of the Rossi-Forel scale has been reduced from all available data up to 1888, and is given below in tabular form. It is, of course, a rough approximation only.

Rossi-Forel scale.	Intensity. millimeters per second.	Difference.
I	20	.....
II	40	20
III	60	20
IV	80	20
V	110	30
VI	150	40
VII	300	150
VIII	500	200
IX	1, 200	700

One of the objects of the earthquake observations on Mount Hamilton is to obtain data for correcting this table, so that the intensity of a shock, as defined mathematically by the formula—

$$I = \frac{V^2}{a}$$

(where V is the maximum velocity of the vibrating particle), can be approximately inferred from the ordinary descriptions of its effects.

STATIONS.

A number of duplex-pendulum seismographs, quite similar to the one used at the Lick Observatory, are placed at different points on the Pacific Coast, but they are not all in operation. The stations are:

Students' Observatory, Berkeley, in charge of Professor Leuschner.

Chabot Observatory, Oakland, in charge of Mr. Burckhalter.

Private observatory of Mr. Blinn, in East Oakland.

Observatory of the University of the Pacific, San Jose.

Observatory of Mills College, near Oakland, in charge of Professor Keep.

Residence of Mr. P. Perrine, 2138 Alameda avenue, Alameda.

Office of State Weather Bureau, Carson, Nev., in charge of Professor Friend.

Other seismographs are located as follows:

Private observatory of Professor Davidson, San Francisco.

Tacoma, Wash., Mr. F. G. Plummer.

CHRONOLOGIC RECORD, 1894.

January 14.—OLYMPIA, WASH.—Mr. Fred. G. Plummer reports a disturbance at 3.25 a. m. A tremor lasting three seconds was followed after an interval of four seconds by a shock from south-southwest, and a slight tremor later. His seismograph at Tacoma barely showed the shock.

VANCOUVER (BRITISH COLUMBIA).—The earth trembled in British Columbia to-day. While the quaking continued, hanging pictures swayed slightly and crockery rattled on the shelves.—San Francisco Chronicle.

January 17.—Reports were published that on January 17 Mount Jefferson, as seen from Salem, Oreg., poured forth smoke and steam from its summit at sunrise. Later explanations showed this to be due to atmospheric phenomena.

January 24.—RIVERSIDE.—Quite a heavy shock of earthquake was felt here this morning at 3.50. The shock lasted several seconds.—San Jose Mercury.

February 5.—KEELER, CAL.—A shock of earthquake was felt at 9.01 p. m.—Newspaper.

February 7.—SAN JOSE.—At 2.09 o'clock there was a slight earthquake shock in this city. There was perceptible but one short, sharp shock.—San Jose Mercury.

February 8.—LOS ANGELES.—News received during the day shows that the earthquake shock felt here at 5.45 this morning was also felt quite generally in this section. It was short and sharp, and there was only one shock.—San Francisco Examiner.

February 15.—HAWTHORNE, NEV.—9.01 p. m. (II.)—Report of Nevada State Weather Service, 1894.

March 3.—MOUNT HAMILTON.—One short shock of intensity III, R. F. 4^h 42^m 50^s 1 p. m.—E. S. Holden.

Rattled stoves, etc., slightly in second and third stories of brick dwelling. 4^h 43^m 1^s p. m.—Mr. and Mrs. W. W. Campbell.

Neither of the seismographs showed any record of this shock.

May 7.—MOUNT HAMILTON.—Two distinct shocks, two seconds apart, of equal intensity. 11^h 56^m 7^s p. m. for the last shock.—E. E. Barnard.

Four shocks in less than 2 seconds, of intensities III, II, II, III, R. F., respectively. 11^h 56^m 16^s ± 10^s p. m. In bed in the third story of the brick dwelling.—W. W. Campbell.

No record of this disturbance was found on either of the seismographs.

MOUNT HAMILTON.—At 10^h 52^m p. m. a movement of the earth was detected by the meridian circle, which was so slight as not to be felt by the observer. The motion was a regular oscillation in an east and west direction, and lasted for fifteen to twenty seconds. At 11^h 56^m 45^s, approximately, one single sharp shock was felt.—R. H. Tucker.

July 13.—**PINE RIDGE, CAL.**—News comes by telephone from Pine Ridge lumber district, 60 miles northeast of this city, to the effect that a sharp shock of earthquake, lasting a few seconds, was felt there at 8.50 last night. The shock was accompanied by the greatest electric display ever witnessed by inhabitants there. The strange feature is that no clouds were noticed by the citizens.—San Francisco Call.

FRESNO, August 16.—Parties arriving from Pine Ridge, 50 miles east of here, state that a recent earthquake (July 13?) injured the dam across Stephenson Creek, by which water is turned into the Pine Ridge flume. The joints in the masonry were damaged sufficiently to allow the water to pass through, but it is believed that no permanent injury was done, as the openings can be plugged.—San Francisco Chronicle.

July 14.—**FRESNO.**—A remarkable phenomenon is reported from the Sierra Nevada Mountains east of Fresno. About sunset last evening a red cloud, apparently 50 miles in length, gradually settled over the range, and as soon as night came on persons in this city observed a wonderful display of electricity on the edges of the cloud.

To-day news from that region says that when the electrical display was at its height an earthquake, violent enough to rattle houses and shake trees, was felt. It continued several seconds. After it had subsided the cloud rapidly passed away and the atmosphere became clear.

So far as can be learned the earthquake was felt at no place else than immediately under the cloud. It was not felt on the plains, 20 miles distant.—San Francisco Chronicle.

July 18.—**OGDEN, UTAH.**—At 3.50 p. m. distinct earthquake shocks were felt. Dishes were shaken from the tables, the walls of some large blocks were cracked, and a general shaking up occurred. Many people were frightened into leaving their houses.—San Francisco Chronicle.

July 29.—**SAN BERNARDINO.**—A shock of earthquake occurred at about 9.15 p. m. The movement was of several seconds' duration, and seemed to be from the northwest to the southeast. The disturbance was very noticeable, causing doors and windows to rattle, chandeliers to swing, and buildings to vibrate. As far as can be ascertained no one was injured and no property destroyed.

The First Methodist Episcopal church was occupied at the time the earthquake occurred. The building is large and built of brick, and the disturbance caused a panic that was soon quelled by those who had presence of mind, though a number sought safety in the open air. The pastor continued his discourse as soon as quiet was restored.

Instances of parties leaving buildings hurriedly are reported.

In the yard at the depot cars standing on the track were put in motion and the men had to set the brakes.

Some report seeing a large meteor in the heavens at the same time the shock occurred.

The clock in the old court-house tower stopped at 9.21 p. m. as a result of the shock.—Newspaper report.

LOS ANGELES.—At 9.12 p. m. the city was shaken by a shock of earthquake, which was one of the most severe felt in this part of the country for many years. The undulations appeared to be from south to north, and there were three distinct tremors. The first was a light one, but the second made the windows rattle and disturbed loose articles lying about on mantels and shelves. With the third tremor the wave passed.

As far as could be learned no damage was done, aside from the breaking of a few panes of glass. The shocks naturally created consternation in some of the large lodging houses and hotels, and caused the inmates to start out in more or less confusion. The tower of the city hall swayed very perceptibly, and the electric-light masts continued to vibrate for fifteen or twenty minutes after the disturbance.

In the restaurants and drug stores along Spring and Main streets the chandeliers swung like clock pendulums and the glassware and crockery rattled at a lively rate. In some places the guests rushed out, leaving their meals uneaten, but soon recovered from the scare and returned.

At the post-office, in the Federal Building, which is one of the most solidly constructed edifices in the city, the shock was very severe, and caused a panic among the clerks. The only damage done, however, was the breaking of several bottles of ink, which were jarred off the shelves.

Up at the grim prison on the hill there was the biggest kind of a scare. The steel floors and partitions, the great steel doors and staircases rattled and creaked and strained.

PASADENA.—A severe shock of earthquake was felt here at 9.17 p. m., lasting ten seconds. The motion was from northwest to southeast, and the shock was accompanied by a loud rumbling. It was felt all over the city, brick buildings being shaken until the bricks creaked. There was much excitement in the churches and meetings, and at the Salvation Army meeting quite a panic ensued; one woman was slightly hurt, and fainted when the crowd was making its exit. No damage was done in the city so far as known. At Echo Mountain the new hotel was shaken.

SANTA MONICA.—Two distinct shocks of earthquake were felt here about 9.11 p. m., the last shock being the heaviest ever felt here. The plate-glass windows in the Hotel Jackson were distinctly seen to wave in and out. No damage has been reported.

SANTA ANA.—At 9.15 o'clock this evening this city was visited by the heaviest earthquake ever experienced here. Buildings shook and glassware and crockery rattled. There were three shocks, the vibra-

tion being from south to north. The electric-light masts continued to vibrate for some minutes after the shock.

MOJAVE.—A heavy shock of earthquake at 9.12 o'clock this evening shook this town badly. Goods were knocked off the counters of stores and general excitement prevailed. The vibration was from north to south.

ONTARIO, CAL.—The severest earthquake shock ever felt here occurred at 9.12 p. m. No damage reported.—*Los Angeles Times*.

August 3.—**MOUNT HAMILTON.**—Professor Holden reports a single shock of intensity III to IV on the Rossi-Forel scale as awakening him at 11^h 50^m p. m. $\pm$ one-half minute. He was expecting an alarm clock to go off, and presumably was easily awakened. The duplex seismograph gave a record of this shock, the displacement of the earth being 0.25^{mm} in an east and west direction.

August 22.—**LEWERS RANCH, NEVADA.**—4.28 a. m. (II).—Report of Nevada State Weather Service, 1894.

September 30.—**MOUNT HAMILTON.**—The record of a single vibration was found on the plate of the duplex seismograph on the morning of October 1. The seismographs were examined on the evening of September 30 and again on the morning of October 1, when the record was noticed, so that the shock must have occurred in this interval, although it was not felt by anyone here and did not start the Ewing instrument. The displacement of the earth was about 0.25^{mm}.

EUREKA.—Two heavy earthquake shocks occurred here this morning, the first at 9.36 o'clock, lasting nearly half a minute. The vibrations were from north to south. The second was at 9.59 o'clock, the vibrations being northeast to southeast. It lasted five seconds. No damage was done.

SISSON.—A slight earthquake shock was felt in this vicinity this morning. The vibrations were from north to south.—*San Francisco Chronicle*.

October.—**NEW HEBRIDES ISLANDS.**—The New Hebrides group passed through a series of heavy earthquakes and volcanic disturbances in October and November, which threatened the existence of several of the largest and best islands, including Ambrim. A layer of ashes from 2 to 6 inches thick covers the once fertile fields.

At Epi, on November 2, there was a severe earthquake in the early morning, which opened an entirely new volcanic crater on the west side of Ambrim, about 14 miles distant, and all the next day the whole island trembled. Since then it has opened in five or six different places. Even the island of Epi, which was much less affected, had to the 7th of November felt sixty-three distinct shocks, and for weeks had been covered by clouds of ashes and smoke. Traders and planters living on Ambrim Island fled precipitately to Port Sandwich (Malicollo), the nearest port, in many cases abandoning all their possessions.

On the 13th of November an earthquake shock rocked Ambrim from

east to west, causing the land on which stood a small native village to slip, with the humble homes of the inhabitants, into the sea. It is impossible to accurately determine the extent of the fatalities, but the lowest estimate of the loss of life is 50. Fatalities are reported from other islands of the group also. Owing to the lateness of the disaster details were not available when the *Warrimoo* left the southern seas, although natives from all the volcanic islands were flocking to the centers of civilization for safety.

The special correspondent of the *Sydney Morning Herald*, writing from Epi early in November, said: "Ambrim Island is still in violent eruption. The outbreak commenced on the 16th of October at an old crater in the center of the island. The lava stream extends from the crater to near Dip Point, at the western end. The center of the island is one mass of lava.

"Frequent earthquakes were felt as far as Malekula, many of them being severe. Some of the officers have ascended the crater, which is 1 mile in diameter and 1,000 feet deep. Dense smoke continues to issue from this crater. The lava streams are moving slowly toward the sea and cooling. All the western end of the island is covered with a deposit of fine ashes. As far as at present can be ascertained the loss of life has been 60 killed by the great landslip of the 13th and by falling stones."

Following is the report made by the commander of H. M. S. *Dart*:

"While we were lying at Dip Point, Ambrim Island, an eruption on that island took place. On weighing anchor at 6 a. m. (October 16) and proceeding to the eastward to resume our surveying work a remarkably heavy mass of cloud was seen rising over the center of the island, and on clearing the point dense columns of smoke were seen descending from just the other side of the low coast range.

"It presently became evident that a lava stream, marked by a dense column of smoke, was making its way through the hills to the sea. The ship was stopped some 300 yards offshore, where it was seen that the stream would emerge, and at 8 a. m. tongues of flame were seen among the trees, and presently the head of the stream appeared, a red-hot, molten mass, with lumps of slag tossing about on the surface.

"When it reached the water a most magnificent sight ensued. A dense pillar of steam rose rapidly in a perpendicular direction to a height which was afterwards found to be 4,500 feet. A few seconds later violent submarine explosions of steam took place, the water rising in huge bubbles some 100 feet high and then bursting in all directions in radiating tongues of water mixed with black masses, presumably of lava. A considerable swell was set outward, and as the area of explosions appeared to be extending rapidly the ship was moved to a safer distance.

"Canoes full of natives were leaving the island in all directions, some of which were taken in tow to Dip Point, where they were clear of

immediate danger. The ship then proceeded around to the south side of the island, when it was seen that the old crater of Mount Maryun, in the center of the island, was in violent eruption, and that dense masses of smoke were rising over all the western end of the island.

"On returning, while rounding Dip Point, a sudden outburst, accompanied by continuous violent explosions, took place. About 2 miles to the southward of Mission Station the cliffs were seen to be falling inland and, when anchoring, flames appeared over the crest of the gap behind the mission.

"The natives were assembled in terrified groups on the beach, and I accordingly sent boats in, offering to take off all that wished. The group was in a state of terror and the noise of the eruption was indescribable. Dust and débris from the burning brush fell continuously. We embarked over 80 men, women, and children, for the most part belonging to Dr. Lamb's mission, and proceeded with them to Rannon, near the northeast point of the island; a place of comparative safety. Throughout the next day earthquake shocks were so severe as to cause resident trader Mr. Rossi, a Frenchman, to remove to Port Sandwich with all his natives and belongings. The natives brought from Dip Point were comfortably housed in the schoolhouse belonging to Dr. Lamb.

"The next morning we proceeded to the northeast point of the island as far as Dip Point, which was found to be in inky darkness; objects being scarcely visible over a quarter of a mile. We communicated with the shore and found the natives reassured, as the actual fires in the vicinity had ceased. At 6 p. m. we proceeded to Port Sandwich, not clearing the shower of dust till more than halfway across.

"Several shocks were experienced on the way, and that night thirty-one shocks were distinctly felt in seven hours forty minutes on board the ship, one at 2.30 a. m. being particularly severe.

"A great portion of the cliff at Dip Point has fallen into the sea, and all along the shore to the eastward continuous clouds of dust are arising and landslides have occurred. We anchored at Rannon afterwards and reembarked all the natives and landed them at Dip Point, the present danger being removed. Dust was now falling heavier than ever, but of lighter color and finer description. Everything on shore was covered with the deposit, the landscape being of one uniform dull slate color and the ship a gray mass. We landed and proceeded over the hill for about 2 miles until the stream of lava was reached. Although cooled down, it was still proceeding at some 4 or 5 feet an hour in the direction of Banlag, on the south coast. Owing, however, to the thickness of the atmosphere it was impossible to get any views of what was happening. We then returned to Port Sandwich."—Extract from San Francisco Examiner.

October 23.—SAN DIEGO.—This city and neighboring towns were visited this afternoon by a series of earthquakes of more than ordinary

severity. The first shock occurred at 3.03 p. m. and was followed at intervals of a quarter of a minute by two others, the last being one of the strongest experienced hereabouts since the advent of Americans. People in brick houses swarmed into the streets, hearing the grinding of brick and mortar and seeing in some cases the walls crack. A loud noise was heard in all parts of the city immediately preceding the shock. Considerable consternation was caused in the public schools, the children in some of the rooms being hastily dismissed.

The second shock was observed by few people, being very light and coming when all were talking of the first; but the third was so pronounced as to bring the people into the streets without delay. Telephone messages from Coronado, Upper Otay Dam, Campo, National City, and other places show that the earthquake was felt about equally at all surrounding points. Loose rocks were shaken from the hillsides and rattled down the canyons, and a heavy booming noise accompanied the tremors.

The weather observer reported another slight shock at about 4.25 o'clock, not so strong as the first ones, but quite perceptible. It was not felt on the ground. The waves were from east to west in all instances. So far as known no serious damage was done.

RIVERSIDE.—Two distinct shocks of earthquake occurred to-day at 3 p. m. The first was light, followed in a few seconds by quite a sharp shake. No damage was done.

SAN BERNARDINO.—Two distinct shocks of earthquake were felt here at 2.04 p. m. The vibrations lasted twenty seconds and the motion was from west to east.

COLTON.—A light earthquake shock was distinctly felt here about 3 p. m.—San Francisco Examiner.

LOS ANGELES.—A slight earthquake shock was felt here at 3.05.—San Jose Mercury.

October 27.—**LOS ANGELES.**—A slight earthquake shock occurred here to-night at about 11 o'clock. No damage is reported.

SAN DIEGO.—An earthquake shock of 10 seconds' duration was felt here at 11.05 to-night. It caused some excitement, but no damage is reported.—San Francisco Chronicle.

November 2.—**MEXICO CITY.**—Two violent earthquake shocks occurred at 4.17 p. m., with four minutes' intermission. During the vibrations the earth seemed rocking like a ship at sea and the natives were on their knees in the streets praying frantically.—San Francisco Bulletin.

November 14.—**GOLD HILL, NEV.**—An earthquake was felt here to-day at 2.02 o'clock. There were two shocks, with an interval of a minute between them. No particular attention was paid to them, most of the people thinking that the disturbances were caused by blasts in the mines.

At 6.58 o'clock this evening a shock occurred that brought the occu-

pants of many buildings into the streets. It was of short duration, but rattled windows and glassware at a lively rate. The vibrations appeared to be from southeast to northwest.—San Francisco Chronicle.

CARSON, NEV.—6.55 a. m. (I).

LEWERS RANCH, NEVADA.—7.05 p. m. (I).—Report of Nevada State Weather Service, 1894.

November 15.—CARSON, NEV.—Three heavy earthquake shocks were felt here. The first and heaviest was at 11.05 p. m., the second at 11.25 p. m., and the third at 12. The direction was east and west. Though the shocks caused fright, no damage was done.—San Francisco Chronicle.

GOLD HILL, NEV.—Three tremors of intensity II. (No time given.)

LEWERS RANCH.—At midnight three tremors of intensity III; felt by persons all over Washoe Valley.

VIRGINIA, NEV.—11 a. m. (II); 11.18 p. m. (II); 11.52 p. m. (II).—Report of Nevada State Weather Service, 1894.

November 16-22.—VIRGINIA, NEV.—There have been, according to different calculations, over one hundred shocks of earthquake in this city within the week. It is in evidence that the greater number of vibrations have come from west to east. Theories without number have been put forward giving reasons why such disturbances should occur in Nevada, which has been almost free from earthquakes since the advent of the white man. There are no Indian traditions in reference to former earthquakes in this vicinity, nor in any portion of Nevada, as far as can be ascertained from the most intelligent of the Indian residents here.

The cone of Mount Davidson shows undoubted evidence of volcanic action formerly, and scoria is found on portions of its western slope. The great gold and silver ore producing mines on its eastern side occupy a depressed amphitheater. Lava is visible on the mountain in small patches, which goes still further to indicate that Mount Davidson is an extinct volcano.—San Francisco Examiner.

November 17.—SAN DIEGO.—A heavy earthquake shock was felt at Campo Saturday evening (November 17) at 5 o'clock, lasting several seconds. The oscillation seemed to be from northeast to southwest.—San Francisco Chronicle.

November 18.—CARSON, NEV.—Earthquake shocks continue to be felt in this section, with prospects of creating a panic if the shocks continue. Between 3 and 7 o'clock this morning six distinct shocks were felt, the first being very heavy. Thus far no damage has been done except to cause acute nausea and prevent sleep. The direction of the vibrations varies considerably, and the shocks are usually preceded by a roaring sound.—San Francisco Chronicle.

AUSTIN, NEV.—10 a. m. (II); Carson, 2.38 a. m. (I); 2.40 a. m. (I); 2.49 a. m. (III); 5.15 a. m. (I); 5.33 a. m. (I); 6.22 a. m. (I).

GOLD HILL, NEV.—Four tremors of intensity II. (No time given.)

LEWERS RANCH, NEVADA.—(No time given.) (I).

VIRGINIA, NEV.—2.28 a. m. (II); 2.30 a. m. (I); 2.40 a. m. (IV) (this shock cracked plastering; in some places walls were damaged; in many instances window glass was broken); 5 a. m. (II); 5.24 a. m. (I); 6.18 a. m. (II).—Report of Nevada State Weather Service, 1894.

November 21.—MOUNT RAINIER (TACOMA), November 26 —F. L. Lowe, a carpenter, says he and some hunting companions were within 6 miles of Mount Tacoma's top last Wednesday afternoon (November 21), and that several shocks of earthquake were distinctly felt at the mountain's base. Several great avalanches were heard crashing down the mountain side and making such a noise that it seemed, Lowe says, as if the world were coming to an end. This occurred on the north side of the mountain. Rocks were piled over 100 feet high in the Puyallup River, and returning they crossed the débris of an avalanche which was of great depth and half a mile wide and 4 or 5 miles long.—San Jose Mercury.

TACOMA, WASH.—To-night at 6.30 o'clock several slight shocks of earthquake were felt here. Windows were rattled throughout the city. The first shock was most severe, being accompanied by rumbling noises, as of a distant explosion, and simultaneously a sheet of flame was observed in the eastern heavens.

CARSON, NEV., in night (I).—Report of Nevada State Weather Service, 1894.

MOUNT RAINIER, WASHINGTON.—Much has been said in the newspapers concerning an appearance of change in the summit of this mountain. The principal facts seem to indicate some sort of change, possibly due to avalanches, and the report that smoke issued from the crater seems worthy of credence.

On the morning of November 21 five reputable citizens of Seattle report that they saw puffs of smoke coming from the west side of the top of the mountain at intervals of twenty seconds from 6.20 to 8 a. m. The smoke came up in huge, balloon-shaped masses, and after hanging suspended for a short time was wafted toward the eastern side of the mountain. Before 8 o'clock the top of the mountain had lost its whiteness, and appeared dark, jagged, and rough.

The same phenomena were observed from Tacoma and Portland.

Again, on the afternoon of Thursday, December 13, smoke was seen rising from the crater by Observer Saulsbury, of the Weather Bureau, E. C. Hobbs, J. A. McClellan, J. J. McGilvera, John Arthur, S. L. Crawford, and others, from Seattle. Mr. Saulsbury saw the phenomenon through a glass repeatedly from 9 a. m. to 1 p. m., and was positive that the substance was smoke and not vapor.

The Seattle Post-Intelligencer sent out an exploring party in the latter part of December to reach, if possible, the summit and determine the character of the phenomena. This party, owing to the dangerous condition of the snow fields, could get no farther than the foot

of Carbon Glacier, from where the following message was sent back by homing pigeon on December 26:

"The expedition has been an entire success. It has demonstrated that while the mountain has been smoking and steaming, the change is due principally to tremendous avalanches and not to an eruption. The new peak observed from Seattle is off Columbus crest, and was formed by spiral winds carrying snow and whipping it into the cone-shaped peak described. The party will be home Friday."—San Jose Mercury.

The Seattle Post-Intelligencer of January 6, 1895, contains a full report of the expedition, which was sent out under its auspices. Without being able to reach the summit, the explorers report having seen, on December 24, jets of steam issuing from the large crater and a column of black smoke from the small crater.

Of interest in this connection is the following report from Ellensburg:

"The eruption of Mount Rainier has explained to the satisfaction of many a mystery that has baffled all. The waterworks reservoir here suddenly became exhausted. Investigation showed a crevice running along the hill north and south, varying from 1 inch to 1 foot in width and of unknown depth. It ran directly through the reservoir, letting the water out. It has been traced several hundred feet along the hill. No shocks of earthquake have been felt here as far as known."—San Francisco Chronicle.

(Ellensburg is over 200 miles distant from Mount Rainier.—C. D. P.)

November 24.—CARSON, NEV.—10.03 p. m. (II); 11.22 p. m. (III).—Report of Nevada State Weather Service, 1894.

December 4.—CARSON, NEV.—9.39 p. m. (I); Lewers Ranch, 9.40 p. m. (II).—Report of Nevada State Weather Service, 1894.

December 18.—CARSON, NEV.—9.08 a. m. (II).—Report of Nevada State Weather Service, 1894.

December 21.—GOLD HILL, NEV.—2.20 a. m. (II).—Report of Nevada State Weather Service, 1894.

December 23.—LOS ANGELES.—Earthquake shocks were experienced this morning at San Diego, Riverside, Pomono, and other points. No damage was done.—San Jose Mercury.

December 24.—BOISE, IDAHO.—Boise was visited by three slight earthquake shocks this morning. The first was very slight, about 4 o'clock; the second light, about 6 o'clock. The third shock was felt everywhere in the city, and came at 7.10 o'clock. Houses vibrated perceptibly and people were awakened. The shock was accompanied by a booming sound like the roar of a gale of wind.—San Francisco Chronicle.

December 28.—GOLD HILL, NEV.—9.15 a. m. (I).—Report of Nevada State Weather Service, 1894.

December 29.—GOLD HILL, NEV.—4.30 a. m. (II); 5 p. m. (I).—Report of Nevada State Weather Service, 1894.

December 30 —CITY OF MEXICO.—At 10.53 o'clock on Sunday (December 30), an oscillatory earthquake shock was felt in this city and other parts of the valley of Mexico. The movement was east and north, but of short duration. The disturbance caused great alarm among those who feared a repetition of the disastrous earthquakes of November 2, which killed 18 people and did great property damage. In the Arben Theater, the only playhouse now open in this capital, as a result of the damage sustained by other theaters in previous shocks, a stampede occurred. Women leaped from lower boxes and the audience struggled for escape at the narrow exits. The manager appeared on the stage and tried to calm the fear-crazed people, and at last a degree of quiet was restored, but not until most of the audience had taken refuge in the streets, which were full of frightened people, many in their night clothes.

The scene of November 2 was repeated in a large part, and thousands of penitents knelt in the open streets and prayed and cried in a loud voice for deliverance from death. In Belem prison, where thousands of wretched beings are huddled together in barracks, pandemonium reigned, and the guards had hard work to prevent hundreds from breaking out and flinging themselves over the walls.

Large supply pipes leading to the city burst, flooding the streets. The shock last night lasted nine seconds. It is known that three persons were seriously injured. A number of buildings were destroyed.—San Francisco Call, January 2, 1895.

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